TRANSACTIONS

OF THE

Royal Canadian Institute

No. 58 | October, 1949 | Vol. XXVIII, Part I

ESTAB. 1849

ROYAL CANADIAN INSTITUTE

ROYAL CHARTER 1851

135 ST. CLAIR AVENUE WEST
TORONTO 5, CANADA

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Date of publication of part I, March 19, 1948.
Date of publication of part II, November 26, 1948.
Date of publication of part III, February 3, 1950.

A TAXONOMIC STUDY OF THE MYSIDACEA AND EUPHAUSIACEA (CRUSTACEA) OF THE NORTHEASTERN PACIFIC

PART III

EUPHAUSIACEA[1]

ALBERT H. BANNER[2]

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[1]The final portion of this study. The first two portions, dealing with the Mysidacea, appeared in this journal: Part I, 26 : 345-399, 1947; Part II, 27 : 65-125, 1948. A contribution from the Department of Zoology, University of Washington, Seattle, Washington.

[2]Department of Zoology and Entomology, University of Hawaii, Honolulu, T.H.

Order EUPHAUSIACEA

INTRODUCTION

The order Euphausiacea belongs to the subclass Malacostraca, the division Eumalacostraca, and the series Eucarida. The only other member of this series is the order Decapoda. The characteristics of the order are set forth below.

The euphausiids are almost purely planktonic, and are largely oceanic. Some are confined to the depths but the majority live near the surface. The species of the upper zones frequently exhibit a pronounced diurnal bathymetric migration. The euphausiids are most important in the food economy of the sea, for they feed largely upon phytoplankton and in turn constitute an important food source for the plankton-feeding fishes and the whale-bone whales.

It is probable that the list of euphausiids from this region is now nearly complete, for the species of euphausiids have wide ranges and sufficient sampling has been carried on to cover the population adequately. However, the list may be augmented during further investigations by stray individuals carried into the region by oceanic currents from the more tropical Pacific, or by the few species that may exist in the depths below 1000 meters, or that may be limited to the Bering Sea and Arctic Ocean.

H. J. Hansen (1915) was the first worker to study the euphausiids of this region and his record of specimens in the U.S. National Museum lists all of the common species. These species are:[3]

(?) *Thysanopoda cornuta* Illig
Thysanoessa spinifera Holmes
Thysanoessa longipes Brandt
Thysanoessa inermis (Krøyer)
Thysanoessa raschii (M. Sars)
Tessarabrachion oculatum Hansen
Euphausia pacifica Hansen

The present study has added the following, all less common than the foregoing, and mostly represented by only a few specimens:

Bentheuphausia amblyops (G. O. Sars)
Thysanopoda dubia sp. nov.
Nematobrachion flexipes (Ortmann)
Nematoscelis difficilis Hansen
Stylocheiron longicorne G. O. Sars
Stylocheiron maximum Hansen

[3]Hansen's listing of *Thysanoessa gregaria* G.O. Sars has not been included for his specimens are believed to be a form of *Thysanoessa longipes*—see page 21.

TABLE I

RANGES OF EUPHAUSIIDS OCCURRING IN THE NORTHEASTERN PACIFIC

	Bentheuphausia amblyops	*Thysanopoda dubia*	*Thysanopoda cornuta (?)*	*Nematobrachion flexipes*	*Thysanoessa spinifera*	*Thysanoessa longipes*	*Thysanoessa raschii*	*Thysanoessa inermis*	*Nematoscelis difficilis*	*Tessarabrachion oculatum*	*Euphausia pacifica*	*Stylocheiron longicorne*	*Stylocheiron maximum*
Arctic Ocean off Atlantic							x	x					x
North Atlantic	x		x	x			x	x				x	x
South Atlantic	x		x	x								x	x
Indian	x		x									x	x
South Pacific	x		x	x								x	x
Tropical W. Pacific	x		x	x								x	x
Northwestern Pacific						x				x	x		
Off California					x	x	x		x		x	x	
Off Oregon					x	x	x				x		
Off Washington Oceanic		x			x	x	x			x	x	x	x
Off Washington Neritic				x	x	x	x		x	x	x		
Off British Columbia	x	x		x	x	x	x	x	x	x	x	x	x
Off Southeastern Alaska		x	x	x	x	x	x	x		x	x		x
Off Southwestern Alaska					x	x	x	x		x	x		x
Bering Sea					x	x	x	x			x		
Adjacent Arctic Ocean						x	x	x					

It can be seen from Table I that the euphausiids exhibit the same types of ranges as did the mysids. The first is the cosmopolitan range, as illustrated by *Stylocheiron maximum*. Second is the circumpolar range, as best illustrated by *Thysanoessa inermis*. Finally is the endemic northern Pacific range, as exhibited by *Thysanoessa longipes* or *Euphausia pacifica*. It will be noted that the euphausiids do not exhibit the narrow range as shown by some of the mysids, with the possible exception of *Thysanopoda dubia;* however, the apparently narrow range of this species is probably due to inadequate sampling.

With the vast amount of material available at the International Fisheries Commission, it was hoped to discover the distributional patterns of the euphausiids for the area under study. For geographic distribution three series of plankton tows, each series taken within a month and extending over a thousand or more miles of coastline, were studied. For seasonal distribution a series of plankton tows taken in a narrow area of Yakutat Bay, Alaska, from January to June, were selected for detailed analysis. For bathymetric study, it was not expected that the tows available would show bathymetric migrations as each tow was taken over a series of depths, but it was hoped that the extremely deep tows (some to 1275 meters) might give indications of vertical stratification; consequently, all tows that sampled depths over 1000 meters were studied. Finally, a series of tows taken off Queen Charlotte Islands, British Columbia, during March of the years 1929, 1931, and 1934 were studied to see if a variation in the population for year to year could be detected. In all, near 20,000 specimens of euphausiids from these 312 plankton tows were identified and counted.

When the study was started it was known that the euphausiids travel in schools of greater or less density, and that random samplings could not present accurate and reliable indications of the abundance of the species. However, it was hoped that as each plankton tow was taken for about an hour, thus sampling a large body of water, and as each locality was represented by a series of tows at different depths, the effects of this swarming could be smoothed out and an accurate distributional picture could be obtained.

However, it was found that the tows were too variable to analyze statistically. Two tows at similar depths in the same area taken within several hours of each other might show hundreds to thousands of specimens of a single species in one tow, while the other would show numerous specimens of different species or no specimens whatsoever. With such variation even methods of statistical analysis could not be applied to show trends in the variation of populations for often supposedly similar tows, taken in the same area at the same time, would show between them greater variation than would tows taken a thousand miles apart at

different seasons.

Consequently, the only conclusions that can be drawn from the entire distributional study are those generalized ones that can be found by mere inspection of the distributional lists: the extremes of the range of the species, whether it penetrates into inland water or not, at what season it appears to be most common, and whether it appears to run in vast swarms. These conclusions were augmented by scattered samples from other sources, as listed in the introduction to Part I. (*op. cit.*, p. 349). As the distributional tables are too voluminous and show too little to be profitably printed, these generalized conclusions alone are listed after the common species. In the uncommon species, where only several specimens were found, the exact data is given.

Definition of the Order EUPHAUSIACEA

Malacostraca in which the well-developed carapace coalesces dorsally with all thoracic segments. Abdomen of six segments; telson without movable furcal rami. Paired eyes well developed and on movable stalks. Protopodite of antenna indistinctly divided into two articles; squame always present. Mandibles with the *pars molaris* and the *pars incisiva*, lacking in the *lacinia mobilis* and saw-bristles; palp seldom absent. Last two pairs of thoracic legs may be rudimentary; exopodites present on all well-developed thoracic legs; first thoracic legs not modified as maxillipeds. Coxa of thoracic legs bearing exposed gills; those of the posterior appendages large and well developed. No oostegites in the females. All genera save *Bentheuphausia* G. O. Sars have complex thoracic and abdominal luminescent organs. First pleopods of the male modified for copulation (except in *Bentheuphausia* ?). Young hatch from eggs as nauplii.

Remarks: All species of this order may be distinguished from the mysids by the characteristics given under Mysidacea (*op. cit.*, p. 355); they may be distinguished from shrimps by the lack of maxillipeds, the presence of a single series of uncovered gills, and by the complex luminescent organs (except in *Bentheuphausia*).

It must be noted that the furcal rami discussed above are not the two large subterminal spines found in this order.

A single family is described from the order.

Family EUPHAUSIIDAE

Characteristics as listed for the order.

This family has been divided into subfamilies, but as these subfamilies are of little aid taxonomically they have not been used in the following

pages. The family contains only eleven genera, eight of which have been found in the northeastern Pacific.

Key to the Genera of the Family of Euphausiidae in the Northeastern Pacific

A. Eighth thoracic legs of reduced size but of full development. Body without luminescent organs.

Bentheuphausia G. O. Sars (p. 7)

AA. Eighth thoracic legs with endopodites of reduced number of articles. Body with luminescent organs.

B. Endopodite of sixth thoracic legs composed of five articles.

C. Endopodite of seventh thoracic legs composed of five articles.

D. Anterior thoracic legs of similar size.

Thysanopoda Milne-Edwards (p. 9)

DD. Third thoracic legs greatly elongate.

Nematobrachion Calman (p. 15)

CC. Endopodites of sixth thoracic legs absent or at most composed of two articles.

D. Exopodite of seventh legs of normal structure, although it may be reduced in size.

E. Third thoracic legs never elongate; second thoracic legs elongate or normal.

F. Second thoracic legs elongate or normal; if elongate, with the propodus bearing stiff setae the full length of both margins.

Thysanoessa Brandt (p. 17)

FF. Second thoracic legs always elongate and bearing setae only on the distal end of propodus; these are modified to the form of stiff spines.

Nematoscelis G. O. Sars (p. 29)

EE. Both second and third thoracic legs elongate.

Tessarabrachion Hansen (p. 31)

DD. Exopodite of seventh legs styliform, endopodite absent in both sexes.

Euphausia Dana (p. 33)

BB. Endopodite of sixth thoracic legs composed of three articles or less; third thoracic endopodite elongate and may be chelate or subchelate.

Stylocheiron G. O. Sars (p. 36)

Bentheuphausia G. O. Sars

Bentheuphausia G. O. Sars, Forh. Vid. Selsk. Christiania (for 1883), (7) : 23.
Bentheuphausia G. O. Sars, Challenger Rept., 13 : 108, 1885.

Eyes reduced in size, peduncle with a papilla. Antennular peduncle short and heavy. Mandibles with an expanded molar portion; palp large. First maxilla with palp small but composed of three articles. Second maxilla composed of five articles. Last thoracic legs reduced in size but similar in structure to the anterior legs. Exopodite of uropods articulated near apex. No luminescent organs. Male copulatory organs of the first pleopods have never been described.

This genus contains one species.

Bentheuphausia amblyops (G. O. Sars)

PLATE I, Fig. 19

Thysanopoda amblyops G. O. Sars, Forh. Vid. Selsk. Christiania (for 1883), (7) : 23.
Bentheuphausia amblyops G. O. Sars, Challenger Repts. 13 : 109, 1885, text fig. 4, pl. 19.
——— Zimmer, Nord. Plankton, (12) : 5, 1909.
——— Hansen, Siboga Repts., 37 : 80, 1910.
——— Hansen, Mem. Mus. Comp. Zool. Harvard, 35 : 206, 1912.
——— Hansen, Proc. U.S. Nat. Mus., 48 : 60, 1915.
——— Zimmer, Deut. Sud-Polar Exped., 15 : 416, 1914.
——— Tattersall, Proc. U.S. Nat. Mus., 69(8) : 12, 1926.
——— Illig, Wiss. Erb. D. Tiefsee-Exped., 22(6) : 490, 1930.

Form heavy. Carapace without denticles (except in immature specimens, see Tattersall, 1926, Illig, 1930); cephalic groove well developed, and with a small keel over the gastric region. Rostrum short and obtuse, with apex rounded.

Corneae of eyes reduced in size, occupying only the distal end of the heavy peduncle, with visual elements irregular and imperfectly formed; peduncle bearing a heavy protuberance that projects over the cornea.

Antennular peduncles heavy. A strong acute tooth arising from the distal end of the first article projects over the second article; lateral to it is a smaller tooth. Second article likewise bearing a projecting distal tooth, about the same size as the secondary tooth of the first article. Both flagella inflated at the base; in the sole specimen in the collection the inflated portion of the lower flagellum is almost as long and as broad

as the two distal articles of the peduncle combined, and bears numerous fine setae arranged in rows along the inner margin.

Basicerite of antenna bearing a small anterior lateral spine. Antennal peduncle slightly shorter than squame. Squame approximately the same length as the antennular peduncle and between 2 and 2.5 times as long as broad; outer margin straight and terminated by a small tooth; anterior margin broadly rounded; a thickened ridge runs the length of the squame.

Exopodite of uropods with a small lateral denticle two-seventh the distance from the tip; slightly distal to this spine is the transverse articulation; outer margin straight and without setae. Uropods equal in length to the telson.

The sole specimen in the collection is 28 mm. long; both Sars and Illig reported specimens reaching 48 mm. in length.

In preserved specimens there is no color visible, even in the corneae; however, Illig reported a color drawing by Chun of a living specimen that showed the body a light red color, the corneae pink, and the eye-stalks colorless.

Discussion: This specimen agrees well with the published descriptions, except for the overdevelopment of the basal portions of the antennular flagella, a condition somewhat similar to that found in some mysids. In this specimen the flagella proper were lost; the basal portion showed segmentation only in the form of oblique striae thickly set with setae along the inner margin. This condition may be a secondary male sexual character, although the pleopods showed no sign of typical euphausiid modification.

The denticles of the antennular peduncles and the rostrum appear to be intermediate between small and mature specimens. The thickened ridge down the middle of the squame has not been previously mentioned in the descriptions of the species; it appears to be similar to the ridge in the squame of many shrimps.

When the specimen was first examined it had in its "food-groove" between the protopodites of the thoracic legs the following animals: two 3 mm. fish larvae; two *Sagitta* of moderate size, one large calanoid copepod, and some material that could not be identified. While most of this material was probably captured while the specimen was in the plankton "bucket" or bottle, it would indicate, at least, that the specimen was actively predacious.

General Distribution: This species is bathypelagic, and has been reported from the North and South Atlantic, the Indian Ocean, the sea south of Australia, and the tropical Eastern Pacific. The depths of capture vary but most are greater than 1000 meters. It has not been reported previously from the North Pacific Ocean.

The male specimen in the present collection: 53 : 34 N; 136 : 26 W (off northern British Columbia), 1200, 1100, 1000 m. (IFC).[4]

Thysanopoda Milne-Edwards

Thysanopoda H. Milne-Edwards, Ann. Sci. Nat., v. 19, 1830.

Rostrum variable, carapace with or without a distinct cervical groove. Corneae of eyes undivided, in some species somewhat reduced. Antennular and antennal flagella elongate. Exopodite of maxilla very small. First to seventh thoracic legs of similar development, the anterior two pairs with a slight modification of the dactylus; the seventh is smaller than those preceding but with the full number of articles in both sexes. Eighth thoracic leg with endopodite degenerate, but with exopodite well developed. Copulatory organs of the first pleopods of the male usually with all parts and processes present; in one species the spine-shaped process is lacking; in others the terminal and proximal processes vary from simple conical spines to complex curved and expanded processes; lateral process also variable; one or two additional processes may be present.

Key to the Species of *Thysanopoda* from the Northeastern Pacific

A. Rostrum of adults rounded, that of young specimens triangular; dorsal process of distal margin of the first antennular article acute.
T. dubia sp. nov. (p. 9)

AA. Anterior margin of carapace of adults rounded and not projecting. rostrum of young specimens rectangular; process on distal margin of first antennular article rounded, not acute.
T. cornuta Illig (p. 13)

Thysanopoda dubia sp. nov.

PLATE I, Figs. 20a-20c; PLATE II, Figs. 20d-20h

Carapace without lateral denticles. Slight keel in gastric regions similar to that of *T. acutifrons* Holt and Tattersall. Frontal region of carapace produced into a triangular rostrum, with the margins over the bases of the eyes slightly convex, but concave near the tip; tip rounded and reaching beyond the eyes. In lateral view the rostral projection is quite thick, only 2.5 times longer than thick. The rostrum in younger specimens is more triangular than that of the adults, and is frequently

[4]As in the first portions of this study, the abbreviation *IFC* indicates that the specimens were taken by the International Fisheries Commission; *OL*, by the University of Washington Oceanographic Laboratory; *USNM*, specimens loaned by the U.S. National Museum.

up-turned distally. Anterior lateral corners of the carapace rounded.

Eyes small in size, similar to those of closely-related species; corneae reddish-brown in color.

Antennular peduncles heavy with the basal article one-sixth shorter than the sum of the two distal articles. The basal article carries dorsally near its end an inflated "cushion" which bears numerous plumose setae. The margin anterior to the "cushion" projects forward as a strong acute tooth over the proximal half of the second article. The anterior lateral margin of the first article bears a short triangular tooth, less than half the length of the dorsal tooth; this tooth is partially concealed by the setae of the anterior margin of the article. Second article bears a row of fine setae at the end of the second third; the anterior dorsal margin projects as rounded collar over the distal article. Third article with a slight dorsal keel that runs obliquely towards the outer distal margin. The flagella are of equal length, about half the length of the body.

Antennal squame reaching to the middle third of the last article of the antennular peduncle; the outer margin is slightly convex; the tip is broad and truncate perpendicular to the outer margin. Basicerite bears two anterior lateral acute processes, the dorsal a quarter the length of the ventral. Antennal peduncles reaching to the middle of the second article of the antennular peduncle. Antennal flagellum is flattened in cross section and almost as long as the entire body.

The pseudexopodite of the maxillules with setae only on the distal margin; palp (or endopodite) reaching beyond the margin of the pseudexopodite by an eighth of its length. Both the pseudexopodite and the endite of the first article full and rounded distally, not tapering towards the tip.

Third article of protopodite of maxilla is equal in length to the final article or endopodite and twice the length of the coxopodite. Endopodite tapering but slightly towards rounded distal end and with inner margin straight to slightly convex.

Dactylus of first thoracic legs short, 0.7 the length of the propodus, armed along the margin with a series of up to 12 unpaired barbed setae which increase in length distally. Dactylus of the second thoracic legs equal in length to that of the first legs but relatively broader. It bears up to 10 unpaired barbed setae along the margin, the barbs being fine triangular plates arranged in a comb-like manner. Proximal to these setae the dactylus carries on its inner ace up to 12 hook-shaped articulated spines, the length of the most distal being two-thirds the width of the dactylus and the most proximal one-sixth the length of the distal. The bases of these spines are triangular, and the distal portion scythe-shaped, with the portion along the concave margin bearing a broad membrane that is evidently composed of very fine, fused setae.

Following legs usual.

Pleura of the abdominal segments similar to those of *T. microphthalma* G. O. Sars. Posterior margins of the fourth and fifth segments not acuminate or acute. Preanal thorn of the females simple. Telson bearing three pair of dorsal spines, similar in location to those of *T. acutifrons*. Inner uropod equal in length to the telson, the outer slightly longer than the inner.

Adult males unknown.

Length of the largest female was 27 mm. No body color noticed in preserved specimens save red setae on the mouth parts and adjacent portions of the anterior thoracic legs.

Diagnosis and Discussion: The lack of lateral denticles on the carapace place this species in H. J. Hansen's group of the genus that includes *T. pectinata* Ortmann, *T. microphthalma* G. O. Sars, *T. acutifrons* Holt and Tattersall, and *T. orientalis* H. J. Hansen. It is easily distinguished from *T. pectinata* by the lack of comb-like bristles on the first article of the antennular peduncle. The three other species and this new species are evidentally closely related and quite similar in form. Table IV shows the more evident differences.

This new species has been erected primarily upon the differences between its rostrum and those of the previously described species; the slight differences in the other anatomical details are hardly of specific worth if taken by themselves. The presence of the scythe-bristles on the dactylus of the second thoracic legs may be an excellent specific character, but until the other species have been re-examined for their presence, too much faith should not be placed upon them. The character of the maxillules and maxilla will separate *T. dubia* from *T. orientalis*. However, final confirmation of *T. dubia* as a valid species must await the description of the first pleopods of the males.

TABLE IV

Differences between *Thysanopoda dubia* and related species[5]

Rostrum:	
T. dubia	Broad, almost entirely covering ocular peduncles, and long, extending beyond eyes; tip formed by gradual continuation of the curves of the lateral margins; width at level of posterior margin of eyes 1.5 times the length anterior to it; in lateral view rostrum 2.5 times as long as thick.

[5]The characteristics of *T. microphthalma* were taken from various descriptions and from the plate of Holt and Tattersall, Fish Ireland. Sci. Rept. for 1904, (2-App. V): pl. II, 1906; those of *T. acutifrons*, from the description and Plate I of Holt and Tattersall, *op. cit.*; those of *T. orientalis* from Hansen, Siboga Exped., 37 : 85, 1910, pl. 13, Fig. 2a-2i, and Mem. Mus. Comp. Zool. Harvard, 35 : 222, 1912, pl. 5, Fig. 2a-2i.

T. microphthalma	Broad but short, covering only the proximal portions of the ocular peduncles; tip demarked from the curve of the lateral margins; over 2.0 times as broad as long; slightly more than 1.5 times as long as thick.
T. acutifrons	More broad and short than *T. microphthalma*, covering only the bases of the peduncles; rostral tip even more discontinuous with the curve of the lateral margins than *T. microphthalma*; over 3.0 times as broad as long; over 2.5 times as long as thick.
T. orientalis	Similar to *T. acutifrons* in shape and coverage of eyestalks; rostral tip also similar; over 2.0 times as broad as long; about 1.3 times as long as thick.

Eye:

T. dubia	In dorsal view, diameter about equal to width of first antennular article.
T. microphthalma	Same.
T. acutifrons	Same.
T. orientalis	In dorsal view, maximum diameter of eye only 0.7 that of first antennular article.

First antennular article:

T. dubia	Dorsal process of anterior margin acutely spiniform.
T. microphthalma	Same.
T. acutifrons	Dorsal process rounded at tip.
T. orientalis	Same as *T. dubia*.

Squame:

T. dubia	Reaching to beyond middle of third antennular article.
T. microphthalma	Reaching scarcely beyond end of second antennular article.
T. acutifrons	Same as *T. dubia*.
T. orientalis	Same as *T. dubia*.

Maxillule:

T. dubia	Endopodite extending beyond pseudexopodite; pseudexopodite bearing setae only distally.
T. microphthalma	Undescribed.
T. acutifrons	Endopodite not extending beyond pseudexopodite (by inference from descriptions); setae of pseudexopodite not described.
T. orientalis	Endopodite extending beyond pseudexopodite or not; pseudexopodite bearing setae on distal half of lateral margin.

Maxilla:

T. dubia	Basis 2.2 times length of coxa; endopodite with lateral margin straight to convex.
T. microphthalma	Undescribed.
T. acutifrons	Described as similar to *T. obtusifrons*, in which the basis is less than 2.0 times length of coxa, and in which the endopodite has a straight lateral margin.
T. orientalis	Basis twice the length of the coxa; endopodite with a concave margin.

Second thoracic leg:

T. dubia	With a series of scythe-like spines on the dactylus.
T. microphthalma. .	None described or shown in plate.
T. acutifrons. . . .	None described or shown in plate.
T. orientalis . . .	Appendage neither described nor depicted.

Telson:

T. dubia	Three pair of dorsal spines.
T. microphthalma. .	Four pair of dorsal spines.
T. acutifrons	Three pair of dorsal spines.
T. orientalis	Undescribed.

Type Specimens: The type specimens of this species will be deposited in the U.S. National Museum.

Specimens in the Collection:

Oceanic Records:

Localities off Washington: 1 specimen collected at 47 : 49 N, 126 : 07 W, 400, 500, 600 m. (IFC).

Localities off British Columbia: 17 specimens in 16 plankton tows at depths ranging from 100-700 m.; most common in months from January to March (IFC).

Localities off Alaska: 1 specimen at 57 : 07 N, 131 : 26 W, 250-420 m. (IFC).

(?) *Thysanopoda cornuta* Illig

Thysanopoda cornuta Illig. Zool. Anz., 28 : 663, 1905.

? ——— Hansen, Mem. Mus. Comp. Zool. Harvard, 35 : 224, 1912, pl. 6, Fig. 1a-1c.

? ——— Hansen, Proc. U.S. Nat. Mus., 48 : 66, 1915.

? ——— Illig, Wiss. Ergebn. D. Tiefsee-Exped., 22 (6) : 513, 1930.

? ——— Tattersall, Proc. U.S. Nat. Mus., 69 (8) : 15, 1926, pl. 2.

Thysanopoda insignis Hansen, Bull. Mus. Ocean. Monaco, (30): 19, 1905.

Carapace without lateral denticles, bearing a deep cervical groove and two pairs of longitudinal ridges, one along the lateral margin and one somewhat dorsal to it. Anterior margin of carapace rounded, in lateral view somewhat upturned, with a dorsal lamellar crest running posteriorly from it to the cervical groove. Eyes moderately small, peduncle bearing a small papilla near cornea. First article of antennular peduncle terminating dorsally in a projecting lobe; outer distal angle bears a short spine. Squame reaching to first third of the third antennular article, and bearing a small tooth on the outer distal angle. Palp of maxillules quite large and protruding. Sixth abdominal segment flattened in its posterior half, the flattened area demarked laterally by a carina. Copulatory organ of males bearing a large spiniform process; proximal and

terminal processes straight and simple, somewhat thickened terminally; lateral process strongly curved and somewhat longer than the spiniform process. Adults reaching almost 80 mm.

Larvae also of large size, still showing larval characters at 15 mm. length. In these the rostrum is well developed and projects over the bases of the eyes as a flat rectangular plate: distally it is sharply truncate and may bear in its middle a long median spine. Distal margin of the first antennular article may bear a long lateral spine (compare Hansen 1912 and 1915, and Illig, 1930).

Discussion: It has yet to be proven definitely that the larvae described by Hansen, Illig and Tattersall are the larvae of *T. cornuta*.

The species is represented in the collection by two larvae. The first specimen, about 15 mm. in length, was lost before the examination was completed. It agreed with Hansen's specimen from the northeastern Pacific (1915) better than it did with the specimen from off the coasts of Peru (1912). It differed from the former in that the carapace had not yet developed pronounced keels and furrows and a long rostral spine; further, the legs were more immature. The first article of the antennular peduncle had a long lateral spine similar to that shown by Illig (1930).

The second specimen was 10 mm. long. The anterior margin of the carapace was produced into the characteristic rectangular plate which reached almost to the end of the first article of the antennular peduncle, and which medially bore a small spine; dorsally no keel could be discerned. The eyes were laterally compressed; their peduncles and a portion of the corneae were covered by the rostral plate. Basal article of the antennular peduncle was armed with a strong lateral spine which reached beyond the end of the second article. Both flagella were short and without articulations. The antenna was represented by a biramous structure without articulations. Only the first two thoracic legs had articulations; the first was somewhat elongate, but the second was short and only about five times as long as broad. The uropods were only half the length of the telson.

General Distribution: Adults have been reported from the tropical and subtropical Atlantic in both the eastern and western portions; from the Pacific they have been reported off the coast of Peru and off southern Japan and the Phillipines. The species appears to be bathypelagic.

Larvae, identified as of this species, were reported by Illig from the South Atlantic and Indian Oceans; by Hansen from the Pacific off the coast of Peru and off the coast of Alaska (53 : 05 N; 138 : 31 W); by Tattersall from the Atlantic off the coast of United States.

Specimens in the Collection:

One specimen at each 53 : 24 N, 136 : 26 W, 1200-1000 m., and 56 : 55 N, 146 : 07 W, 900-700 m. (IFC). (Specimen from first tow lost.)

Nematobrachion Calman

Nematodactylus Calman, Trans. Royal Irish Acad., 31 : 16, 1896.
Nematobrachion Calman, Fish. Ireland Sci. Invest. for 1902-1903, (pt. 2-App. IV) : 153, 1905.

Carapace with a cervical groove, usually without denticles on the lateral margin. Eyes with a transverse constriction. Antennular peduncle not showing sexual dimorphism; flagella long and slender. Mandibles with a three-jointed palp. Maxillules with or without pseudexopodite. Coxa and basis of maxilla relatively broad. First and second thoracic legs of similar size, the second with the dactylus short and broad. Third leg elongate; articles without setae or spines except for the dactylus which bears six stiff spines; merus with a sharp bend near proximal end; carpus and propodus elongate and thin. Following legs small and decreasing in size posteriorly. Endopodite of seventh leg with a normal number of articles in both sexes; exopodite normal. Endopodite of eighth legs absent; exopodite normal. Copulatory organs of the first male pleopods with all lobes present and with all processes, including the additional process, present and well developed.

Three species, only one of which has been found in this region.

Nematobrachion flexipes (Ortmann)

Stylocheiron flexipes Ortmann, Erg. d. Plankton-exped., 2 (G, b): 18, 1893, Taf. I, Fig. 7.
Nematodactylus flexipes Calman, Trans. Royal Irish. Acad., 31 : 16, 1896.
Nematobrachion flexipes Calman, Fish. Ireland Sci. Invest. for 1902-1903, (pt. 2-App. IV) : 153, 1905.

Pacific Records:
——— ——— Hansen, Mem. Mus. Comp. Zool. Harvard, 35 : 269, 1912, Pl. V, Figs. 5a-5m.
——— ——— Hansen, Proc. U.S. Nat. Mus., 48 : 110, 1915.
——— ——— Hansen, Proc. U.S. Nat. Mus., 49 : 651, 1916.

Frontal triangle of carapace variable; rostrum very slender and laterally compressed; lateral margins with or without denticles—when present, they are located at the beginning of the posterior third of the carapace, and are narrow at the base, elongate and acute, and directed laterally and forwards.

Eyes constricted below the middle, with the upper portion broader than the lower.

Antennular peduncles rather slender. First article distally bearing a strong lateral spine; second article with a terminal dorsal spine which arises from a lamellar protuberance; third article with a small dorsal keel.

Squame reaching to the middle of the third article of the antennular peduncle, strongly tapering and with the terminal tooth of the lateral margin well developed. Basicerite with a strong spine.

Maxillules without a pseudexopodite. Maxilla with the endite of the second article of the protopodite divided into two lobes; terminal article or endopodite almost twice as long as broad.

Thoracic legs as described for the genus.

Abdomen bearing a denticle of variable size on the posterior margins of the third to sixth segments, with the denticle of the third segment usually half as long as the fourth segment, and those of the fourth to sixth segments much shorter. Pleura of the second to fifth abdominal segments with the posterior angle acute and somewhat produced. Both rami of the uropods approximately equal in length to the telson.

Copulatory organs of the male[6] with the spiniform process moderately developed and slightly curved. Terminal process has a heavy base, a curved and narrow neck and an expanded and flattened terminal portion. The proximal process has a broad base and an elongate and strongly curved shaft that, when the pleopod is unrolled, crosses over the terminal process to bend back again and ends with its flattened tip beyond the end of the terminal process. The lateral process is set far out on the median lobe, and reaches slightly beyond the end of the lobe; its tip is strongly recurved. Accessory process heavy and strongly curved towards the setose lobe.

Mature specimens reach more than 22 mm. in length.

Discussion: The three specimens in the present collection agree almost completely with the redescription of Hansen (1912). In the characters that appear to be most important for specific identification within this genus—the antennules, the mouth-parts, and the copulatory organs—there is complete agreement. Other characters, like the form of the rostrum, the shape of the eyes, and the dorsal spines of the abdomen likewise are similar. However there appear to be three differences.

The first of these is possibly a major difference. Not only does *N. flexipes*, as previously described, lack lateral denticles on the carapace, but also the genus was defined by Hansen (*ibid*) as lacking in these denticles. On two of the three specimens in this collection the denticles are very pronounced; on the third specimen the bases of the denticles are present, while the denticles appear to have been broken off.

A second difference of less importance is in the prerostral triangle of the carapace, which Hansen describes as low, and shows the central angle to be about 110°. In all specimens in this collection the triangle was higher and the central angle was 90°.

[6]The anatomy of the copulatory organs can best be understood by studying Hansen's figures (1912).

The third difference noted is not certain to be a true difference. On all three specimens the dorsal surfaces of the large subapical spines of the telson bear a series of about fifteen closely-set secondary spines of heavy form; the longest is equal in length to about a quarter of the maximum breadth of the subapical spine. A similar condition has not been described for *N. flexipes*, although it may have been overlooked.[7]

Whether these two, or possibly three, differences are a sufficient basis upon which to erect a new species in view of the similarity of other specific characters cannot be decided upon the basis of three specimens —more should be examined to determine whether these are constant characters. The apparently wide geographical separation of these specimens from the previously recorded specimens of the tropics would lead one to believe that, in spite of the similarities, two distinct populations are represented which, while closely allied, are actually separate geographically and morphologically.

General Distribution: This species is listed by Rudd (1936) as being one of the surface species of the tropics limited by the 15° (at 100 M.) isotherms; he cites it as occurring normally in the top 200 m. In the Pacific all previous records have been from the eastern and western tropical regions; the most northerly record is 13° 12′ N. near the Philippines (Hansen, 1915).

Specimens in the Collection:

All collections from the oceanic waters off Alaska. One specimen at each:

51 : 30 N, 130 : 24 W, 600, 500, 400 m.
53 : 40 N, 134 : 15 W, 300, 200, 100 m.
56 : 09 N, 137 : 05 W, 300, 200, 100 m. (IFC)

Thysanoessa Brandt

Thysanoessa Brandt, Middendorf's Sibirische Reise, 2 (1) : 128, 1851.

Rostrum well developed. Eyes with or without a transverse constriction. Distal articles of the antennular peduncle more narrow in the female than in the male; upper flagella usually considerably shorter than the peduncle. Mandibular palp small. Terminal article or endopodite of maxilla short. Epipodite of first thoracic leg obsolete. First six thoracic legs with full number of articles; second leg may be elongate, and if elongate with the entire margins of the propodus and dactylus bearing stiff setae. Endopodite of seventh legs present in females, but composed of only one or two articles, at most slightly longer than exo-

[7]No other species of euphausiid from the northeastern Pacific shows a similar armature, and to my knowledge the condition has never been described before in the order.

podite; endopodite absent in males; exopodite present in both sexes. Endopodite of eighth legs absent in both sexes; exopodite represented by a styliform process.

Copulatory organs of the first male pleopods with the spine-shaped process of the inner lobe thin and curved; the proximal, terminal and lateral processes well developed; additional process usually is lacking, or if present, very poorly developed.

Of the nine species of this genus, five have been reported from the northeastern Pacific. The record of one of these species, *T. gregaria* G. O. Sars, appears to be based upon incorrectly identified specimens, and therefore has been cancelled from the list. (See discussion under *T. longipes* Brandt, p. 21.)

Key to the Species of *Thysanoessa* in the Northeastern Pacific
(Based upon characters of adult males)

A. Terminal process of copulatory organs simple, not tubiform.
  B. With a protruding setose lobe on the distal end of second article of antennular peduncle.
    T. spinifera Holmes (p. 18)
  BB. Without a protruding setose lobe on the distal end of second article of antennular peduncle.
    T. longipes Brandt (p. 21)
AA. Terminal process of copulatory organs tubiform in its distal half.
  B. Lateral process gradually curved and with its base near level of base of proximal process.
    T. inermis (Krøyer) (p. 24)
  BB. Lateral process abruptly bent to almost 90° near middle, and articulated on middle lobe near middle of proximal process.
    T. raschii (M. Sars) (p. 27)

Thysanoessa spinifera Holmes

PLATE II, Figs. 21a-21d

Thysanoessa spinifera Holmes, Occ. Papers Calif. Acad. Sci., (7) : 299, 1900, Pl. IV, Fig. 81.
——— Hansen, Bull. Inst. Ocean. Monaco, (210) : 38, 11, 1911.
——— Hansen, Univ. Calif. Publ. Zool., 11 : 174, 1913.
——— Esterly, Univ. Calif. Publ. Zool., 13 : 11, 1914.
——— Hansen, Proc. U.S. Nat. Museum, 48 : 90, 1915.
——— Tattersall, Contri. Canad. Biol. 8 : 185, 1933.

Rostrum triangular and very acute, tip reaching to near end of first article of antennular peduncle. Gastric area of carapace bearing a dorsal keel that continues anteriorly past the middle of the rostrum. Anterior lateral margin of carapace produced into an acute denticle over eyes. Lateral margins without denticles.

Eyes large and subspherical, slightly narrower dorsally than ventrally, but without a transverse constriction in adults.

Antennular peduncles of the female with the second article a third longer and almost a third broader than the terminal article. Second article of males slightly more than a third longer than terminal article, and with its dorsal distal margin produced into a lobe bearing thickly and regularly set recurving setae. Both second and third articles of male somewhat thicker than those of the female. In both sexes the upper flagellum is about the length of the peduncle, the lower three-fourths the length of the upper. Squame reaches to the neighborhood of the second article of the antennules, slightly longer in the females than in the males, with the terminal denticle well developed.

Second thoracic legs not elongate in adults, but usually slightly longer and somewhat thicker than the third legs. However, in immature specimens this pair of legs is often markedly elongate. Carpus and propodus of subequal length, both bearing setae along the entire margins. Dactylus almost as broad as long, one-seventh the length of the propodus, and bearing strong setae. Following legs normal. Endopodite of seventh legs of females consists of a single article in adults; in immature specimens it is lacking.

All abdominal segments dorsally keeled in adults, but keels not pronounced upon the first two segments. On the fourth, fifth and sixth abdominal segments the keel projects posteriorly as a strong acute process, with that of the fourth segment longest and strongest. Preanal spine simple in both sexes. Telson with two pair of dorsal spinules. Uropods slightly shorter than the telson.

Spiniform process of male copulatory organs thin and usually curved through more than a 90° angle, with the tip often yet further curved. The terminal process is short and heavy, between 2.5 and 3.0 times as long as broad at the base, tapering quite evenly to the tip; when the pleopod is unrolled there is a more or less sharp bend in the shaft and the tip appears broad and rounded; but when the process is viewed from the side, the shaft has a rather even curve and the tip is seen to be hooked. The proximal process is longer and thinner than the terminal process, and reaches to near the end of the terminal process; it is slightly curved beyond its middle; like the terminal process, when the pleopod is unrolled it does not appear to be greatly curved at its tip, but in side view it appears almost hooked.

The lateral process arises from the median lobe at the level of the base of the proximal process, or slightly distally. Its shape is similar to that of the proximal process, with or without a terminal hook. The median lobe shows a dimple-like area of thin chitin when cleared in caustic potash where the additional process articulates in other genera; in one specimen a short additional process was seen on one pleopod, but not on the other. Distally the median lobe is truncate, and its end, together with a "v"-shaped insert on the lobe, is composed of thinner chitin than the rest of the appendage.

Females of this species in the collection reach a length of 38 mm.

Discussion: Adults of this species can be confused only with *T. longipes*, and the armature of the abdominal segments affords a rapid and accurate method of distinguishing the two species.

The younger specimens vary somewhat from the adult form. The eyes may have a slight constriction, and the second thoracic legs may be somewhat elongate. In some postlarval specimens the denticle that projects over the base of the eyes is not well developed. In one specimen the posterior lateral margin of the carapace bears a slight irregularity that might be interpreted as a poorly developed denticle.

The first pleopods of the males examined were very similar to those described by Hansen, except the proximal and terminal processes were relatively thinner in these specimens, and the lateral process was set further distally on the median lobe. These are not specific differences, but appear to be individual variation.

General Distribution: Since the species was described from Fort Bragg, California, the species has been collected along the western coast of North America from southern California (about 32° N.) to the south eastern Bering Sea.

Specimens in the Collection:

Neritic Records (all IFC and OL):

Washington: 46 specimens in 14 plankton tows, from surface to 175 m., penetrating into the inland waters as far as Jefferson Head, Puget Sound.

British Columbia: 59 specimens in 12 plankton tows, from 35 m. to 100 m.; penetrating into Portland Canal.

Alaska: 352 specimens in 13 plankton tows, from 50-175 m.

Oceanic Records (all IFC and OL):

Off California: 1 specimen, 1 plankton tow, 275 m., 39 : 41 N, 139 : 52 W.

Off Washington: 27 specimens in 11 plankton tows, from 40 m. to 900 m.

Off British Columbia: 751 specimens in 43 plankton tows from 35 m. to 900 m.

Off Alaska: 701 specimens in 99 plankton tows, from 50 m. to 900 m.; farthest north specimens: 59 : 32 N, 147 : 48 W.; farthest west specimens: 54 : 27 N, 158 : 03 W.

Thysanoessa longipes Brandt

Thysanoessa longipes Brandt. Middendorff's Sibirische Reise, 2 (1) : 128, 1851, Pl. VI, Figs. 1-14.

——— ——— Hansen, Bull. Inst. Ocean. Monaco, (210) : 38, 40, 1911.

——— ——— Hansen, Proc. U.S. Nat. Mus., 48 : 90, 1915, Pl. I, Figs. 3a-3d, Pl. II, Figs. 1a-1e.

——— ——— Schmitt, Canad. Arctic Exped. 1913-1918, 7 (B) : 86, 1919.

——— ——— Tattersall, Contri, Canad. Biol., 8 : 185, 1933.

Thysanoessa gregaria Hansen, (*partim*), Proc. U.S. Nat. Mus., 48 : 101, 1915.

Thysanoessa armata Marukawa, Annot. Ocean. Research, 2 (1) : 4, 1928, Taf. 2, Figs. 19-22.

Carapace produced into a narrow keeled rostrum, and also produced lateral to the base of the rostrum into a rounded flange that projects over the bases of the eyes. Lateral margin of carapace bears a small denticle on its posterior half.

Eyes large and with a transverse constriction above the middle. Both distal articles of the antennular peduncle in the female elongate and slender, with the third article more slender and longer than the second. In the male the articles are more heavy than in the female, with the third article only slightly thinner than the second. Flagella about the length of the last two peduncular articles. Squame reaching to near middle of third antennular article.

Second thoracic legs very elongate, with the end of the merus reaching beyond the end of the antennular peduncle. Ischium and merus heavy. Carpus somewhat curved, about 18 times as long as broad, and distally bearing six or more strong setae. The propodus is 0.4 as long as the carpus and over 10 times as long as broad; it bears 15-20 setae on both margins. The dactylus is more broad than long and bears four strong setae.

Abdomen with the third to fifth segments with strong keels, the keel of the third segment often produced posteriorly into a strong compressed spine that extends over the initial third or fourth of the fourth abdominal segment; the fourth and fifth segments may be produced in a similar manner to form smaller spines. A posterior median spine arises from the end of the sixth segment without any preceding keel. Telson bears

two pair of dorsal spines. Inner uropod equal in length to the telson, but slightly longer than the outer uropod.

Copulatory organs of the male with the spine-shaped process curved. The terminal process is elongate, curved in the basal half, and tapers slightly from the base to the rather obtuse tip. The proximal process is more straight, and its tip reaches almost to the end of the terminal process. The lateral process is straight and tapering, and is inserted at the level of the base of the proximal process or somewhat distal to it with its tip reaching to the level of the tips of the other process. Median lobe with a broad tip that is composed of thin chitin; the thin chitin extends a fifth the length of the lobe in a "v"-shaped insert. No vestige of an additional process seen in the specimens examined.

Discussion: Nothing could be found in Marukawa's short description or plates that would serve to distinguish *T. armata* from *T. longipes*. As his specimens were collected well within the known range of *T. longipes*, his species has been placed in synonymy.

This species contains two different forms, the large form as redescribed by Hansen (1915) which is easily recognized by the long spines on the posterior margins of the abdominal segments, and a smaller form without these spines. The smaller form is superficially similar to *Thysanoessa gregaria* G. O. Sars, and can be distinguished from that species only with difficulty. However, *T. gregaria* is distinguished by the following characters that are found in neither form of *T. longipes*.

1. The proximal and terminal processes of the copulatory organ of the male are short, heavy and broadly truncate.
2. The abdominal segments are without keels.
3. The end of the merus of the second thoracic legs does not reach to the end of the peduncles of the antennules.
4. The pseudexopodite on the maxillules is broader.
5. The terminal article of the maxilla is less than half as long as the penultimate article.

Of these differences, the most reliable is the first, for the processes in *T. longipes* are elongate and gradually tapering to an acute although often recurving tip.

The spineless form is consistently smaller than the spined form with the mature individuals seldom exceeding 15 mm. in length. Examination of the copulatory organs of these specimens leaves no doubts as to their maturity, for the processes were well developed and in some specimens were carried in an expanded state, indicating that the organ had been functional.

The spineless forms agree perfectly with the spined form on all characters of primary taxonomic importance, as the form of the rostrum, the lateral denticles of the carapace, the divided eyes, the antennular

and antennal peduncles, the mouth parts, the elongate second thoracic legs, and the presence of dorsal ridges on the abdominal segments. Finally, there is perfect agreement between the two forms in the copulatory organs.

The two forms appear to differentiate rather early, for quite young specimens have either well-developed spines or none at all; in postlarval specimens of the spined form, however, only the spine of the fourth abdominal segment may be developed.

Some variation was noted in the eyes of the spineless form that was not observed in the spined form. In some specimens of the smaller form the eyes were only two-thirds the diameter of the eyes of other specimens of similar size. Intergrading eye sizes were found on other specimens. A similar variation in the size of the eyes was noted for *T. gregaria* by Hansen (1915).

Careful examination of specimens from all parts of the range, including the examination of copulatory organs, yielded none that approached *T. gregaria*. This would indicate that *T. gregaria* does not commonly occur so far north in the Pacific, and possibly never occurs in the area covered by this study. The only records of *T. gregaria* occurring within this area were those of Hansen from the Bering Sea; these records are based upon two females, and it is most likely that these are spineless *T. longipes*. Therefore the record has been placed under this species.

Both forms of *T. longipes* are fragile. Especially so is the spineless form, and the majority of the specimens in the collection have burst eyes and broken thoracic legs. This is probably a result of thinner-than-usual chitin, which is also indicated by the light stain taken by the exoskeleton after it has been cleared in caustic potash.

General Distribution: Brandt's type specimens came from the Sea of Okhotsk. Hansen's specimens came largely from the Pacific north of 50° N. and from the Bering Sea, with only one specimen in the eastern Pacific as far south as Puget Sound. Schmitt reported two specimens from the Arctic Ocean near Pt. Barrow, Alaska. Tattersall reported specimens from both the open ocean and from the inland waters of southern British Columbia. In the present collection this species was second in abundance only to *Euphausia pacifica* Hansen.

Specimens in the Collection:

Neritic Records:

Washington: 14 specimens in 7 plankton tows, mostly in the inland waters, penetrating as far as Jefferson Head, Puget Sound. (OL).

British Columbia: 42 specimens in 5 plankton tows, in inland waters of the northern section. (OL).

Alaska: 177 specimens in 9 plankton tows, mostly in south central Alaska. (IFC and OL).

Oceanic Records:

Off California: 5 specimens in 1 plankton tow, 0-275 m., 34 : 51 N, 145 : 29 W. (OL).

Off Oregon: 49 specimens in 6 plankton tows, 0-275 m. (OL).

Off Washington: 135 specimens in 15 plankton tows, 40-900 m. (IFC and OL).

Off British Columbia: 1,902 specimens in 71 plankton tows, 40-1200 m.; specimens most plentiful in top 300 m. during the months from March to May. (IFC and OL).

Off Alaska: 3,329 specimens in 159 plankton tows, taken from 0-1500 m.; most plentiful in upper 300 m., but occur throughout the entire spring season (other seasons are not represented well in the collections). Most northern record: 59 : 32 N, 147 : 48 W. Most western record: 54 : 19 N, 160 : 03 W. (IFC and OL).

Thysanoessa inermis (Krøyer)

PLATE III, Figs. 23a-b

Thysanopoda inermis Krøyer, Gaimard's Voyage, 1846, Pl. 7, Fig. 2a-t.

Thysanopoda borealis G. O. Sars, Forh. Vid. Selsk. Christiana (for 1882), p. 52, Pl. 1, Fig. 16-18.

Boreophausia inermis G. O. Sars, Norske Nordhav. Exped., (14) : 13, 1886.

Rhoda inermis Stebbing, Ann. and Mag. Nat. Hist., ser. 7, 5 : 10-11, 1900.

Rhoda inermis Zimmer, Nord. Plankton, (12) : 11, 1909, Fig. 11-12.

Thysanoessa neglecta Krøyer, Gaimard's Voyage, 1846, Pl. 7.

Thysanopoda neglecta Hansen, Vid. Medd., 1887, p. 54.

Thysanoessa aberdonensis Sim, Scottish Nat., 1872, p. 184, Pl. 5, Fig. 1-8.

Thysanoessa borealis G. O. Sars, Forh. Vid. Selsk. Christiania (for 1882), pp. 9, 52-53, Tab. 1, Fig. 16-18.

Thysanoessa inermis Hansen, Bull, Inst. Ocean. Monaco, (210): 13 *et seq.*, 1911.

Records from the northeastern Pacific:

---------- Hansen, Proc. U.S. Nat. Mus., 48 : 93, 1915, Pl. 2, Figs. 2a-2d.

---------- Schmitt, Rep. Canad. Arctic Exped. 1913-1918, 7 (B) : 8b, 1919.

---------- Tattersall, Contri. Canad. Biol., 8 : 185, 1933.

Rostrum reaching to near end of first article of antennular peduncle, broad at base, acute at tip. Lateral margins of carapace without den-

ticles. Eyes either slightly higher than wide and without constriction, or markedly higher than wide with a transverse constriction between the upper third and the lower two-thirds.

Relative length of the articles of the antennular peduncle the same in the male as in the female, but the distal articles of the males are about 1.5 times as heavy as those of the females. The basal article of the female peduncle bears a small tooth on the anterior lateral margin, and two small rounded lobes on the anterior dorsal margin that project over the base of the second article. The second article in the females terminates without teeth or lobes. The basal article of the males bears an anterior lateral spine and an adjacent rounded lobe similar to that of the females, but the third lobe is greatly produced and bears many closely-set stiff setae. The second article bears distally two elongate processes, both about a third the length of the third article; the lateral process is "sausage"-shaped, distally curved, and without setae; the medial process is broader and flattened, and bears a group of stiff recurved setae. The third article bears a heavy dorsal crest near the distal end. Squame reaches from slightly beyond the end of the second antennular article to middle of the third article.

In the *forma inermis* all thoracic legs are of approximately equal development; in the *forma rhoda* the second thoracic legs are elongate and heavy, with the end of the merus reaching to the end of the antennular peduncle, the carpus and propodus also elongate, and the dactylus short.

Abdomen without keels, but the sixth and sometimes the fifth segment of abdomen bears small denticles on the posterior middorsal margin.

Copulatory organs of the male with the spine-shaped process of usual form and development. The terminal process is three times as long as broad at the base, with the proximal third broad and terminated by a distinct knee; the distal half is narrower and tubiform, the tube being formed by the rolling together of the margins of the process; the tip is blunt. The proximal process is thinner than the terminal process, and ends near the tip of the latter; the distal third is slightly curved. The lateral process arises from the median lobe near the level of the basis of the proximal and terminal processes; it is about twice as thick near its base as is the proximal process, and is strongly but gradually curved distally; its tip reaches to the level of the tips of the other processes. The median lobe has a pronounced shoulder on its outer side.

Discussion: As shown by the above description and list of synonyms, this species is composed of two forms which were previously considered to be separate species under separate genera. The *forma inermis* is characterized by round unconstricted eyes and thoracic legs of subequal lengths; while the *forma rhoda* is characterized by constricted eyes and

elongate second thoracic legs. Hansen (1911 and 1915) has an excellent discussion of this variation.

The specimens in the collection can be divided into two series by a variation not noted by Hansen in his discussions. Those of the first series, represented by both *forma inermis* and *forma rhoda* are of typical structure but of small size, much smaller than those reported from the Atlantic, with the females reaching a maximum of only 17 or 18 mm. in length and with mature males as short as 12 mm. All of the second series are of *forma inermis* and are of greater size, 17-22 mm. long, but are markedly immature. In all characters of taxonomic importance the two series are similar, except for two rather minor differences: in the large form the antennal squame reaches to the middle of the third antennular article instead of to the end of the second article as it does in the smaller form; in the large form the distal article of the maxilla is 1.4 to 1.6 times as long as broad instead of 1.8 to 2.0 times as long as broad as it is in the small forms. The lobes of the male antennular peduncle are not developed and the processes of the copulatory organs are short and spiniform in the large form; both of these are due to the sexual immaturity of the specimens.

It is quite possible for the larger form to be a separate species or at least a different subspecies but without mature individuals available for comparison and in view of the already described variation within this species, it would appear better to place the form under this species.

General Distribution: This species has been reported from numerous localities in the North Atlantic, as far south on the American coast as Cape Cod, on the European coast as Britanny, and as far north as 78° N. along the coast of Greenland. Rudd (Danish Ocean. Exped., 2 (D-6): 37, 1936) states that it is confined to coastal waters.

In the north Pacific, Bering Sea, and adjacent regions of the Arctic Ocean, there have been few records of its capture. Hansen reported the species from five localities in the Bering Sea and two localities in the Pacific, the furthest south being at 46° 39′. Schmitt reported the species from two localities along the Arctic coast, one near the Alaskan-Canadian border, the other near Pt. Barrow, Alaska.

Specimens in the Collection:

Neritic Records:

Off Alaska: 459 specimens in 12 plankton tows. Furthest west specimens 55 : 07 N, 161 : 14 W. (IFC, OL, USNM).

Oceanic Records:

Off British Columbia: 7 specimens in 4 plankton tows, ranging from 100-270 m. Furthest south record: 51 : 56 N, 128 : 52 W. (IFC).

Off Alaska: 2088 specimens in 80 plankton tows, ranging from 100-1200 m. Furthest north record: 59 : 33 N, 140 : 34 W. (IFC, USNM).

(Note: To judge from stomach samples of 23 whales landed at Akutan, Alaska, this species appears to constitute their principle "schizopod" food in those waters, being the only euphausiid in the stomachs of 90% of the whales.)

Thysanoessa raschii (M. Sars)

PLATE III, Figs. 22a-b

Thysanopoda raschii M. Sars, Forh. Vid. Selsk. Christiania, 1863, pp. 83-84.

Euphausia raschii G. O. Sars, Forh. Vid. Selsk. Christiania, (18) : 9, 51, 52, 1892.

Boreophausia raschii Norman, Rep. Fish. Board Scotland, 8 : 156, 1886.

Rhoda jardineana Sim, Scottish Naturalist, 1872, p. 6, Pl. 4, Fig. 4.

Rhoda raschii Zimmer, Nord. Plankton, (12) : 11, 1909, Fig. 13-14.

Thysanoessa raschii Hansen, Bull. Inst. Ocean. Monaco, (210) : 13, 1911.

Records from the North Pacific:

— — — Hansen, Univ. Calif. Publ. Zool., 11 : 174, 1913.

— — — Esterly, Univ. Calif. Publ. Zool. 13 : 10, 1914.

— — — Hansen, Proc. U. S. Nat. Museum, 48 : 96, 1915.

— — — Schmitt, Rept. Canad. Arctic Exped. 1913-1919, 7 (B) : 681, 1919.

Tattersall, Contri. Canad. Biol., 8 : 185, 1933.

Rostrum broad, but not reaching to end of first article of antennular peduncle. In the females the rostrum near the end abruptly tapers to a subacute angle. In the males the whole rostrum is broader than in the females, with the distal portion expanded and broader than the proximal portion; the tip is rounded. Lateral margins of carapace bear a pair of well-developed denticles anterior to the middle of the margin.

Eyes large and subspherical.

First article of the antennular peduncle bearing a spine on the anterior lateral margin. In the males the first and second articles bear dorsally small setose lobes that project over the following articles; the lobe of the first article is longer than that of the second. In both sexes the third article is longer than the second. Squame reaches beyond end of second antennular article.

Anterior thoracic legs of similar size and development.

Abdomen without keels and denticles; posterior margin of sixth segment straight. Uropods usually but not always shorter than the telson.

Copulatory organs with the spiniform process well developed and curved. The terminal process has a broad base; the first quarter of its length proceeds at a slight angle to the base, and remains almost as broad as the base; the distal three-quarters is demarked from the proximal quarter by a rounded knee, and is curved and tapering to a bluntly rounded tip; the distal half consists of an incomplete tube formed by the rolling together of the margins of the process. The proximal process is somewhat more than half as broad as the terminal process and about three-quarters as long; it tapers gradually from slightly above the base and is slightly curved; the tip is subacute, strongly bent, but not hooked. The lateral process is articulated on the median lobe distal to the level of attachment of the proximal and terminal processes; it is as broad and almost as long as the proximal process, and tapers to a hooked tip; it is so strongly bent as to make the distal portion lie at an angle of 80° to the proximal portion. In all specimens examined a small accessory process was present on the median lobe; it is of thin chitin and less than half the length of the spiniform process.

Discussion: A slight confusion, probably due to a typographical error, is found in Esterly's key (*op. cit.* p. 10), for the description of the eyes of *T. gregaria* (Sars) and *T. raschii* are reversed, and to *T. raschii* is attributed bilobate eyes.

General Distribution: Like *Thysanoessa inermis* (Kroyer) this species is known both from the north Atlantic and north Pacific. In the eastern portion of the Atlantic it is known from the Norwegian and British coasts, and in the western portion it reaches as far south as Cape Cod. The species penetrated a considerable distance into the adjacent Arctic Ocean.

In the Pacific it has been reported from numerous localities from California (39 : 25 N) to the Bering Sea and adjacent portions of the American Arctic Ocean.[8] It has never been reported from the western Pacific.

Specimens in the Collection:

Neritic Records:

Washington: 681 specimens in 43 plankton tows, from 0-175 m. Most plentiful in early spring months. Penetrated inland waters as far as Richmond Beach (Seattle). (OL)

British Columbia: 40 specimens in 3 plankton tows, all in or near Portland Canal. (OL)

Alaska: 43 specimens in 2 plankton tows off St. George Island, Bering Sea, (56 : 30 N, 169 : 30 W) at surface. (Personal collection)

[8]Hansen (1913) lists some specimens from "Admiralty Head, Whitby Island" which undoubtedly should be Whidby Island, Washington. See footnote 9, p. 35.

Oceanic Records:

Off Oregon: 2 specimens in 1 tow at 45 : 39 N, 124 : 49 W, 0-100 m. (OL)

Off British Columbia: 21 specimens in 8 plankton tows, from 35-1200 m. (IFC)

Off Alaska: 222 specimens in 32 plankton tows, from 100-1200 m. Northernmost and westernmost records listed above.

Nematoscelis G. O. Sars

Nematoscelis G. O. Sars, Forh. Vid. Selsk. Christiania, 1883, No. 7.
—— G. O. Sars, Challenger Rept., 13 : 127, 1885.

Rostrum variable. Eyes with a transverse constriction. Antennular peduncles slender and elongate in the females, shorter and thicker in the males. Mandibular palps small. Second thoracic legs elongate, with setae only on the distal end of the propodus and dactylus. Seventh thoracic legs with the endopodite composed of two articles in the female, wanting in the male; expodite present in both sexes. Eighth thoracic legs represented by a simple setose plate. "The copulatory organs possess the three processes on the inner lobe, but the spine-shaped process is nearly straight and nearly parallel with the two other which are inserted on the end of the lobe. The lateral process is never hook-shaped and the additional process is wanting." (Hansen, 1911).

Seven species, only one of which is present in the northeastern Pacific.

Nematoscelis difficilis Hansen

Nematoscelis difficilis Hansen, Bull. Inst. Ocean. Monaco, (210) : 48, 1911, Fig. 18.
—— Esterly, Univ. Calif. Publ. Zool., 13 : 12, 1914, Figs. 1, 2, 4, 12, 15, 22, 34, 35.
—— Hansen, Proc. U. S. Nat. Mus., 48 : 107, 1915.
Nematoscelis megalops (Ortmann, Bull. Mus. Comp. Zool. Harvard, 25 : 103, 1894 (*partim?*).
Nematoscelis microps Ortmann, *loc. cit.* (*partim*).

Form slender. No thoracic or abdominal denticles. Rostrum long and thin in the females, reaching to near the end of the first article of the antennules. Rostrum in the males varies from a condition similar to that of the female to an acute tip of the triangular anterior margin of the carapace; usually an intermediate condition is found where the rostrum is short and very thin.

Eyes in lateral view 0.7 as broad as high, with a transverse constriction above the middle.

Antennular peduncles in both sexes shorter than the carapace (0.8 the length of the carapace in females, 0.9 in males). In a representative male the first article was 2.0 mm. long, the second article was 1.0 mm. long and had a maximum width of 0.5 mm., and the third article 0.8 mm. long and 0.45 mm. broad. In a female of similar body length the proportions were: first article, 2.0 mm. long; second article, 1.2 mm. long, 0.4 mm. broad; third article 1.3 mm. long and 0.3 mm. broad. Flagella longer than the peduncles in the males, shorter than the peduncles in the females.

Squame reaches to the middle of the third antennular article in the females, almost to the end of the third article in the males.

Second thoracic legs very elongate, with the end of the merus (or the "knee") reaching beyond the end of the antennular peduncle; combined lengths of articles distal to the knee slightly shorter than those proximal; propodus eleven times the length of the dactylus and with a group of strong secondarily-spinose bristles on its extreme end; dactylus short and broad, bearing numerous bristles similar to those of the propodus. Third to sixth thoracic legs with a full number of articles, but of increasing shortness. Seventh and eighth thoracic legs as described under the genus.

Copulatory organs of the male with the spiniform process straight and about half the length of the terminal process. Distal half of the terminal process set at a distinct angle to the basal half, and with tip strongly curved and bearing about 27 strong serrations. Proximal process about 0.8 the length of the terminal process; the distal 0.4 of the outer margin is set with fine serrations. Lateral process equal in length to the spiniform process, but articulated on the median lobe so that its tip reaches near to the end of the proximal process.

The largest specimen in the collection, a female, reaches a total length of 25 mm.

Discussion: This species, known only from the Pacific, is closely related to *N. megalops* G. O. Sars from the Atlantic. The two species are separated only by differences in the pleopods of the male.

The specimens in the collection agreed very well with Hansen's descriptions, with the exception of one male whose proximal process was slightly longer than that described by him or than that of other specimens in the collection. As no other differences were observed on this specimen, the difference was ascribed to individual variation.

General Distribution: This species has been reported only in the papers cited under synonymy. The records were all from the eastern

Pacific from 26° N. to 39° N. The depths of capture were seldom below 300 fathoms, and seldom at the surface.

The specimens in the collection extend the range of the species to the inland waters of Washington and to Queen Charlotte Sound, British Columbia.

Specimens in the Collection:

2 specimens in 1 plankton tow at 41 : 58 N, 136 : 40 W, (off Oregon). (OL)

23 specimens in 2 plankton tows at Pillar Point, Straits of Juan de Fuca and Jefferson Head, Puget Sound, Washington, 150 m. (OL)

2 specimens in 2 plankton tows off the Queen Charlotte Islands, British Columbia, from 100-600 m. Northernmost specimen 51 : 50 N, 130 : 24 W. (IFC)

Tessarabrachion Hansen

Tessarabrachion Hansen, Bull. Inst. Ocean. Monaco, (210) : 47, 1911.

Rostrum wanting. Eyes large, constricted slightly above the middle. Antennular peduncle without lobes or lappets; the first article is the most broad; second and third articles more broad in the males than in the females; flagella flattened, more broad in the male than in the female. Maxillules with the palp and pseudexopodite moderately large. Maxilla with the two endites incised and with the terminal article short, exceeded in length by the exopodite. First thoracic legs with the merus four times the length of the three distal articles. Second and third thoracic legs elongate with the merus and carpus elongate, almost devoid of setae; propodus only slightly elongate and armed with numerous setae; dactylus almost as broad as long. Following three pair of legs normal. Endopodite of seventh thoracic legs in the female composed of two articles and longer than the exopodite, but lacking in the male; exopodite present in both sexes. Endopodite of eighth legs lacking in both sexes, and exopodite reduced to a single styliform article.

Copulatory organs of the males consisting of a simple rounded plate which bears two or three marginal bristles instead of the middle and inner lobes as found in other genera; setose and auxiliary lobes, the latter with coupling hooks, well developed.

Discussion: In both the original description and in the later more detailed description (Proc. U. S. Nat. Mus., 48 : 102, 1915), Hansen described the copulatory organs of the males with reservations, believing that their reduced condition indicated immaturity. As no more fully developed males were found in the rich material available in the present

collection, it must be presumed that this is the adult condition, in spite of the fact that males were greatly exceeded by the females in size.

This genus contains only one species.

Tessarabrachion oculatum Hansen

Tessarabrachion oculatum Hansen, Bull. Inst. Ocean. Monaco, (210): 45, 1911.

- - - Hansen, Proc. U. S. Nat. Museum, 48 : 103, 1915.

- - - - Tattersall, Contri. Canad. Biol. 8 : 185, 1933.

Frontal margin of carapace projecting as an upturned flange or collar above the bases of the eyes; where the two flanges meet medially they project somewhat to an acute or slightly rounded point. Lateral margins of carapace without a denticle. Abdomen without keels or spines.

Eyes large, higher than broad, with a very slight constriction above middle; upper portion varying from almost as broad as, to broader than, the lower portion.

Third article of antennules of the female more slender and slightly longer than the second article; antennular flagella about the length of the two distal peduncular articles. The second article of the peduncle in the males is heavier than that in the females, and the third article is equal in diameter to the second; the flagella are somewhat longer than in the female. Squame reaches to the middle of the third article of the antennular peduncle.

Second and third legs elongate, similar in form and with the merus reaching to or beyond the end of the antennular peduncles; carpus 2.5 times the sum of the length of the two distal articles and armed with two distal bristles; propodus armed with widely-set stiff bristles; dactylus broader than long, about 0.1 the length of the propodus, and closely set with long stiff bristles. Fourth, fifth and sixth thoracic legs of normal construction and small in size, of decreasing size posteriorly.

Sixth abdominal segment equal in length to the sum of the fourth and fifth segments. Telson with two pairs of dorsal denticles.

Male copulatory organs as described under the genus.

Maximum length of females 26 mm., of males 20 mm.

General Distribution. The only previous records of this species were made by Hansen (1915), when he reported specimens from off Alaska, from the Bering Sea, and from off Northern Japan.

Specimens in the Collection:

Neritic Records:

Oregon: 3 specimens in 1 plankton tow at 43 : 39 N, 124 : 49 W. (OL)

Washington: 2 specimens in 2 tows, penetrating as far as the mouth of Hood Canal. (OL)

British Columbia: 1 specimen in 1 plankton tow, 100-275 m. (OL)

Oceanic Records:

Off Washington: 23 specimens in 8 plankton tows, ranging from 40-900 m. (IFC and OL)

Off British Columbia: 202 specimens in 36 plankton tows, ranging from 40-900 m. (IFC and OL)

Off Alaska: 451 specimens in 84 plankton tows, ranging from 100-1500 m. Northernmost record: 59 : 33 N, 140 : 34 W; westernmost record: 54 : 27 N, 158 : 03 W.

Euphausia Dana

Euphausia Dana, U. S. Explor. Exped., 13 (1) : 639, 1852.
———— G. O. Sars, Challenger Rept., 13 : 63, 1885.

Rostrum and lateral denticles of carapace variable. Abdomen with or without dorsal denticles. Eyes undivided. Antennular peduncles not showing sexual dimorphism, with the basal article carrying a lappet in some species; both flagella elongate. Maxilla with terminal article broad and exopodite small. Anterior six pairs of thoracic legs subsimilar in structure, none elongate. Exopodite of seventh and eighth thoracic legs represented by an unjointed styliform article; endopodite lacking on both legs in both sexes.

Male copulatory organs with the basal portion of the terminal process of the inner lobe broadened into a "foot" of varying breadth, which carries a proximally projecting protuberance, the "heel", also of varying size. The proximal process well developed. The lateral process may carry one to three teeth. The spine-shaped process and the additional process lacking in almost all species.

This large genus reaches its maximum development in the tropical regions and only one species penetrates into the area covered by this paper.

Euphausia pacifica Hansen

PLATE III, Figs. 26a-d

Euphausia pacifica Hansen, Bull. Inst. Ocean. Monaco, (210) : 28, 41, 1911.
——— ——— Hansen, Mem. Mus. Comp. Zool. Harvard, 35 : 241, 1912, Pl. 7, Figs. 5a-b.
——— ——— Hansen, Univ. Calif. Publ. Zool., 11 : 174, 1913.

Euphausia pacifica Esterly, Univ. Calif. Publ. Zool., 13 : 6, 1914, Pl. 1, Figs. 9, 14, Pl. 2, Figs. 18, 19, 27, 29.

- - Hansen, Proc. U. S. Nat. Mus., 48 : 81, 1915, Pl. 1, Figs. 2a-2g.

- - - - Tattersall, Contri. Canad. Biol., 8 : 181, 1933.

Anterior margin of the carapace slightly projecting as an obtuse or rounded plate, without a rostrum. Dorsal surface of carapace without keels. Lateral margin of carapace with a strong denticle near its middle.

Eyes large and spherical.

First article of the antennular peduncle bears a row of recurving bristles on its dorsal surface anterior to the eye; the distal end produced into an acute dentate process that projects over the second article. Second article bears a similar but much smaller denticle. Third article with a short dorsal carina. Antennal squame not greatly tapering, with its end almost transversely truncate and with a small outer terminal denticle; end reaching slightly beyond the end of the second antennular article.

Abdomen without denticles or keels; sixth abdominal segment about 1.5 times as long as the fifth.

Spine-shaped process of the male copulatory organs lacking. Terminal process with a rather long foot; heel rather short when compared to other species of this genus, but pronounced and angular; distally the process is first constricted and then broadens to a flat blade that lies at right angles to the main process, so rotated that when the organ is fully unrolled it is visible only as a bulbous end. Proximal process with a thick base, flattening distally into a long blade which likewise cannot be seen in its entirety because of its rotation when the process is normally unrolled; slightly proximal to this blade, and often appearing to merge with the blade because of the rotation of the process, is a second broad, thin, and distally rounded tooth. Lateral process strongly hooked. Accessory process may be present or absent. When present it arises from the median lobe near the hook of the lateral process, and usually is simple and styliform in shape, but it may be hooked and notched. Median lobe appears crested when unrolled. Setose lobe bearing a large triangular lobe that folds over its face.

Females reach the length of 25 mm., males reach 22 mm.

Discussion: The copulatory organs of the males of these specimens do not agree with the descriptions of Hansen on two points. First, he describes the proximal process as bearing "no secondary branch on the outer side", but "near its base [of the distal blade] an incision is seen . . . ." (Hansen, 1915, p. 83). A series of males in the collection from all parts of the range here represented were studied on this point. They were cleared in caustic potash and stained in fast green to show better the

relationships of the parts. All showed that the incision was deep enough to separate entirely the distal widening from the proximal widening so that there was the formation of a secondary blade. A comparison of Fig. 26b, Plate III of this paper with that of Hansen (Fig. 2g, pl. I, Proc. U. S. Nat. Mus. v. 48, 1915) show the processes to have similar profiles; without clearing the appendage in caustic potash, the overlapping plate would appear to merge with the distal blade as is shown by Hansen. This secondary blade evidently is the one spoken of by Esterly, but the fine serrations noted by him were not observed in these specimens.

The second point wherein the specimens differ from the descriptions is in the possession of the additional process. Its presence has already been noted by Esterly, who speaks of it as occurring in all the specimens he examined. In the specimens that were studied in detail the process was present on only about two-thirds of the specimens. Where it occurred it varied from a simple conical process, weakly chitinized and easily obscured by the lateral process or by the median lobe itself, to a rather complex process of harder chitin shown in Fig. 26d, Plate III.

General Distribution: This species is one of the most common euphausiids in the north Pacific, occurring off America and Asia both in coastal and oceanic waters, from 25° N., to 59° N.[9] It is the most plentiful species in the present collection. It was collected in all areas from Washington to southwestern Alaska and the Bering Sea. It penetrates into inland waters in numbers. Both the tows studied under seasonal distribution and the miscellaneous tows indicate that it may be most common in February, and the geographic tows indicate that it may be most common off northern British Columbia, and much less common off southwestern Alaska. While numerous at the surface, it penetrates below 1000 M. In both oceanic and neritic waters it occurs in vast swarms.

Specimens in the Collection:

Neritic Records:

Washington: 1026 specimen in 55 plankton tows, penetrating as far as Richmond Beach, Seattle. (OL and IFC)

British Columbia: 135 specimens in 11 plankton tows. (IFC and OL)

Alaska: 174 specimens in 8 plankton tows including collections in the Bering Sea. (IFC and OL)

[9]Hansen (1913), gives the locality for one of his specimens as "Admiralty Head, Whitby Island, Alaska"; Admiralty Head, Whidby Island, is at the mouth of Puget Sound, Washington.

Oceanic Records.

Off Oregon: 4 specimens in 3 plankton tows, 0-250 m., southernmost record 44 : 58 N, 136 : 40 W. (OL.)

Off Washington: 507 specimens in 11 plankton tows, 0-900 m. (IFC and OL.)

Off British Columbia: 3323 specimens in 90 plankton tows, 70-1200 m., most plentiful in upper 300 m., and in spring months. (IFC and OL.)

Off Alaska: 3203 specimens in 171 plankton tows from 0-1500 m.; northernmost record 59 : 33 N, 140 : 34 W; westernmost 54 : 08 N, 160 : 47 W. (IFC and OL.)

Stylocheiron G. O. Sars

Stylocheiron G. O. Sars, Forh. Vid. Selsk. Christiania, 1883, no. 7.
G. O. Sars, Challenger, Rept. 13 : 136, 1885

Form of body and rostrum variable; carapace without lateral denticles. Eyes usually divided. Antennular flagella of a small number of elongate articles, with the second and third articles elongate and thin in the female, shorter and thicker in the male, and with the distal articles round in the female, flattened and sometimes expanded in the males. Antennal peduncle extending beyond the end of the squame. Mandibles without palps. Maxillules without pseudexopodite. Maxillae with endopodite reduced and the endites of the protopodite without the incision separating them into two lobes. Second thoracic legs similar to first thoracic legs. Third legs elongate, with the merus and carpus elongate and without setae. The propodus of these legs are swollen and bear stiff setae that meet those of the short dactylus in opposition, forming a grasping organ that in some species approaches a true chela. Following legs short and decreasing in size posteriorly, sixth endopodite composed of three articles in the females, three or less articles in the males; seventh endopodite composed of two articles in the female, rudimentary in the males; eighth endopodite lacking in both sexes. Only three light organs.

First pleopods of male with the inner lobe coalescing with the median lobe for almost its entire length and bearing the usual three processes. Median lobe bearing the lateral process near the point of union with the lateral lobe. Additional process wanting. All processes quite simple.

Nine species, two of which are found in the northeastern Pacific.

Key to the Species of *Stylocheiron* in the Northeastern Pacific

A. Dactylus of elongate legs bearing numerous long stiff bristles.
S. longicorne Sars (p. 37)

AA. Dactylus of elongate legs bearing no bristles.
S. maximum Hansen (p. 39)

Stylocheiron longicorne G. O. Sars

PLATE IV, Fig. 25a

Stylocheiron longicorne G. O. Sars, Forh. Vid Selsk. Christiania, (7) : 32, 1883.

G. O. Sars, Challenger Rept., 13 : 144, 1885, Pl. XXVII, Fig. 5.

Holt and Tattersall, Fish. Ireland Sci. Invest. for 1902-03, 1905, p. 109.

Stylocheiron mastigophorum Chun, Bibl. Zool. 7 (19), 1896.

Records from the Pacific:

Stylocheiron longicorne Hansen, Siboga Exped. 37 : 120, 1910, Pl. XVI, Figs. 5a-5b.

Hansen, Mem. Mus. Comp. Zool. Harvard, 35 : 279, 1912, Pl. 11, Figs. 9a, 9b.

Hansen, Proc. U. S. Nat. Mus., 49 : 652, 1916.

Boone, Bull. Vanderbilt Mus., 6 : 211, 1935.

Stylocheiron suhmii Ortmann, Bull. U. S. Fish. Comm. for 1903, 3 : 966, 1905 (*partim*).

Rostral plate triangular, with or without rostrum. Carapace with a low keel over the gastric area. Eyes about twice as high as broad, upper portion as broad as or broader than the lower portion. Antennular peduncles longer than the carapace; male peduncles slender except for the proximal article which is somewhat thickened; lower flagella of males composed of seven articles, the distal articles being flattened and serrate along the margin; flagella of females slender. Squame 13 to 15 times as long as broad, in the females its tip reaching to the end of the second antennular article, and in the males reaching to the middle of the third article.

Propodus of elongate legs bearing three spines, the longest 0.7 the length of the propodus, distally curved towards the dactylus and serrate along the inner margin. Dactylus demarked by a fine articulation from the terminal spine, the dactylus and spine reaching slightly beyond the end of the large spine of the propodus; the terminal spine is also curved and finely serrate. Proximally the dactylus bears four shorter spines.

"The copulatory organs show some minor differences from those of *S. affine.* The terminal process is a little more than three times as long as broad, with its basal third somewhat broader than the next third, but without any real angle between these two parts; the

terminal part is somewhat widened, spoon shaped, seen from behind broadly rounded, seen from in front the terminal and a short part of the lateral margin are curved forward and furnished with about six saw teeth, as the whole distal part is diaphanous these teeth are visible through the skin when seen from behind. The proximal process is a little shorter and distally narrower than the terminal, and shaped as in *S. arcticus*. The lateral process at the base a little removed from the proximal process and besides much shorter and less than half as broad; it is somewhat sinuate, not expanded distally, and there cut off very obliquely on the outer side." H. J. Hansen, (1922), *loc. cit.*

The males of this species reach 9 mm. in length, the females 13 mm.

Discussion: Unfortunately the three specimens in the collection were small and damaged females, only one with an elongate leg present. However, as there is excellent agreement in the diagnostic characters of the eyes, the antennular peduncle, the antennal peduncle and squame, and in the chela of the elongate legs, there is little doubt that these are *S. longicorne*. The only differences are in the anterior region of the carapace: in the specimen from California the rostral plate is an elongate triangle terminating in an acute rostral spine that extends beyond the eyes. In the specimen from Washington this plate appears as an equilateral triangle, terminating in an acute angle at the level of the distal end of the peduncles. In the specimen from British Columbia the plate is broadly rounded, in the middle bearing a short rounded extension which is terminated by a short spine, the whole only slightly more than covers the bases of the ocular peduncles. The first two specimens agree with the variation noted by Hansen, the third has not been described before, but it is likely to be merely a further variation.

General Distribution: This species has been reported from many localities in all regions of the north and south Atlantic from 64° 08' N. to south of Cape of Good Hope. It has also been reported from the Mediterranean Sea and Indian Ocean.

In the Pacific most records have been made in the western tropical regions, from the East Indies, the Philippines and adjacent areas. Boone's specimens came from the Marquesas Islands, and Ortmann's from near the Hawaiian Islands. The specimens listed below are the first record of this species from the north temperate Pacific, and the first record off the western coast of America.

Specimens in the Collection:

1 specimen at 33° 20' N., 121° 30' W., 200 m. to surface. (Scripps Institution).

1 specimen at 47° 49' N., 126° 07' W., 700, 800, 900 m. (IFC).

1 specimen at 52° 28' N., 131° 48' W., 400, 500, 600 m. (IFC).

Stylocheiron maximum Hansen

PLATE IV, Figs. 26a-26j

Stylocheiron maximum Hansen, Danish Ingolf Exped., 3 (1) : 92, 1908.
Hansen, Siboga Exped., 37 : 121, 1910, Pl. 16, Fig. 6a-6d.
Hansen, Mem. Mus. Comp. Zool. Harvard, 35 : 283, 1912.
Hansen, Proc. U. S. Nat. Mus., 48 : 112, 1915.
Hansen, Proc. U. S. Nat. Mus., 49 : 653, 1916.

Rostrum long, extending almost to the end of the first article of the antennular peduncles, and apparently formed by the confluence of the high thin collar of the anterior margin of the carapace above the eyes, so that the rostrum is deeply "v"-shaped in section. The anterior portion of the carapace bears a short high keel that extends from the base of the rostrum to the gastric region; the keel is about four times as long as high.

Eyes large, with a slight constriction above the middle; in adults the upper portion is only slightly narrower than the lower portion.

Antennular peduncles of the female with the distal articles thinner than those of the male. Upper flagellum of males as long as the peduncle and consisting of a proximal group of fused articles and four elongate separate articles, the distal articles of which are flattened but not greatly broadened. Lower flagellum of males 1.3 times as long as the upper, and consists of eight or nine elongate articles which are triangular in cross section. Flagella of females longer and composed of more articles. Squame acuminate, with the outer margin concave and distally ending in a strong tooth. Antennal flagellum almost half as long as body.

Chela of third thoracic legs 0.7 as long as the carpus; the hand is over four times as long as broad and 1.6 times the length of the dactylus. The fixed finger, which is a modified spine whose articulation can be faintly seen, is as long as the dactylus and strongly curved distally; in addition to this finger, the propodus bears a second spine which is less than half as long as the fixed finger. Dactylus composed of a basal 0.6 which represents the true dactylus, and which is about five times as long as broad, and a strongly curved terminal claw which is only half as broad as the basal portion. The fused articulation between these two parts is even more faint than the articulation between the fixed finger and the propodus. The dactylus also bears three short heavy and curved spines at its distal end; the articulations of these spines are likewise fused.

Abdomen without dorsal spines or ridges. Sixth abdominal segment 1.6 times as long as the fifth. The telson is 1.2 times as long as the sixth segment and bears two pairs of dorsal spines. Uropods slightly longer than the telson.

TABLE III. COMPARISON OF THE [illegible] ORGANS OF FIFTEEN SPECIMENS OF [illegible]

I.F.C. [illegible]	Total Length of Body	Terminal Process p2		Proximal Process p3		Lateral Process (p1) Length	Length Ratio p2:p3	Length Ratio p3:p1	[illegible]	
		Length	Length Breadth	Length	Length Breadth				Length	[illegible]
2042a	22 mm.	100?	7	105?	8	Not fnd.	0.90	—	75?	[illegible]
3016	23 mm.	120	7	120	7	55	1.05?	0.50?	167?	[illegible]
106a	23½ mm.	110	5	150	7	40	0.85?	0.30	145?	75?
131b	24 mm.	120	5?	115?	6	50	1.05	0.40	170?	105?
153	24 mm.	120	4	115	5	55	1.05	0.50	175	110?
185c	25 mm.	180	7	165	5½	100	1.10	0.60	230	[illegible]
186a	25 mm.	100	7	150	4	40	1.00	0.35	105?	67?
1263a	25 mm.	150	3½	145?	4½	80	1.05	0.50	170	100?
129a	25½ mm.	120	4	75?	4½	67	1.50	0.70	165?	85?
332d	26 mm.	110	5	85?	5	27 55	1.20?	0.55?	150?	120?
23*	26 mm.	120	4	110	5	65	1.10	0.60	165	135?
2056	26 mm.	135	5	135	8	35	1.05?	0.25	100?	85
129c	27 mm.	150	5½	120	4	105?	1.05?	[illegible]	175?	105?
622b	28 mm.	150	5½	120	4	50?	1.25	[illegible]	[illegible]	150?
42a	28½ mm.	135?	4½	135 - 150	[illegible]	90?	[illegible]	1.75?	250?	[illegible]
293a	29 mm.	150?	5	105?	4	75	[illegible]	0.70	225?	[illegible]

Copulatory organs of male variable, but in mature specimens the spiniform process is curved, the terminal and proximal processes are rather heavy and terminate in a spoon-like depression and the lateral process is variously developed.

The largest female in the collection reaches 33 mm. in length, the largest male 29 mm.

Discussion: All but one of the specimens in the collection agree with Hansen's brief description except for the copulatory organs. In these organs so much variation was observed that the copulatory organs of every mature and sub-mature male in the collection, fifteen in all, were dissected and studied. No two specimens were similar. The measurements of these organs are presented in Table III, and drawings of some of the more contrasting developments are shown in Plate IV.

As can be seen from the tabulation and the figures, between various individuals there appear to be differences which are normally considered to be of specific worth. The differences are especially marked in the specimen from I. F. C. 332d and 429a which have an extra process; in the specimens from I. F. C. 622b and 429e, with their heavy *p2* and *p3*, and relatively long *p4*; in the specimen from I. F. C. 189a with long and thin *p2* and *p3* and a relatively short *p4*; and finally the specimen from I. F. C. 2056e with a heavy *p1*, with *p2* and *p3* about average, with *p4* very short, and the entire median lobe dwarfed. The specimens with extra processes appear to be mutants, for there is no other recorded instance of the duplication of a process; the last specimen may also be a mutant, or it may represent a new species (see below). Between the rest there are intergrading specimens.

It may be that many of these differences are due to the different degrees of maturity of the specimens. For example, there appears to be a rough correlation between the length of the specimen and both the thickness of *p2* and *p3* and the length of *p4*. Some of the differences may be due to individual variation.

The specimen in I. F. C. 2056e not only has an aberrant copulatory organ but has a markedly different rostrum which instead of being produced into a long and acute process, merely consists of the joining

FOOTNOTES for TABLE III

a. Records of capture of these specimens: 2042a. 51:50 N, 132:16 W, 100-300 m. 2/28/41. 391d. 51:34 N, 130:00 W, 100-300 m. 5/25/31. 166a. 47:54 N, 123:54 W, 100-300 m. 3/7/29. 431b. 56:24 N, 141:04 W, 100-600 m. 6/8/31. 453 55:32 N, 136:25 W, 100-1500 m. 6/16/31. 185e, 52:25 N, 131:57 W, 700-900 m. 3/16/29. 189a. 54:08 N, 134:06 W, 100-300 m. 3/17/29. 1293a. 54:10 N, 134:00 W, 100-300 m. 1/13/35. 429a. 55:25 N, 141:12 W, 100-300 m. 6/7/31. 332d. 53:31 N, 136:26 W, 1000-1200 m. 1/30/30. 230c, 58:16 N, 139:34 W, 700-900 m. 3/4/30. 2056e, 52:46 N, 132:34 W, 700-900 m. 3/2/41. 429e, 55:25 N, 141:12 W, 1300-1500 m. 6/7/31. 622b, 53:40 N, 134:15 W, 400-600 m. 3/28/32. 293a, 53:52 N, 158:20 W, 100-300 m. 1/12/30.

b. Length of median lobe taken from level of articulation proximal process.

c. Breadth of median lobe taken at point of maximum breadth distal to level of proximal process.

d. Other males of 22 mm. total length or shorter were too immature to include in this table.

e. Units of measurement arbitrary and of only relative significance.

f. Specimen has either an extra p4 or a p5; ratio computed on the basis of the longer process.

g. Specimen has an extra p3; ratios computed on the basis of the longer process.

of the supraocular flange behind the eyes. However, considering the variation of the rostrum noted in this and other genera, and considering the great similarity between this and all other specimens in the form of the eyes, antennules, antennae, third legs, and other characters of specific importance, it was decided to place provisionally this specimen in the already existing species and to defer further judgment until a series of similar individuals are studied.

General Distribution: *S. maximum* has been reported from Barents Sea in the Arctic Ocean, in the Atlantic from 61° 40' N. to 40° 56' S., with numerous records from the tropical Atlantic and Mediterranean Sea. It has been reported from the Indian Ocean. The records from the north Pacific are few, chiefly from the tropical eastern Pacific and off the Philippine Islands. This is the first report from the northeastern Pacific.

Specimens in the Collection

Oceanic Records:

Off Washington: 3 specimens in 2 plankton tows, 100-600 m., southernmost record at 47° 19' N., 126° 07' W.

Off British Columbia: 10 specimens in 25 plankton tows, 100-900 m.

Off Alaska: 29 specimens in 20 plankton tows, 100-1,500 m., northernmost record at 59° 20' N., 143° 50' W., westernmost record at 55° 28' N., 155° 16' W.

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APPENDIX

Artificial Key to the Species of Schizopods Known to Occur in the Northeastern Pacific

This key, to the species that have been reported from the Northeastern Pacific, has been arranged to facilitate the recognition of the individual specimens rather than show the phylogenetic relationships of the species. To accomplish this, characteristics of easy recognition on single specimens have been chosen as far as possible. However, as sexually dimorphic characteristics at times are the most important for the identification of a genus or species, these characteristics are included in parentheses in the key.

The numbers following the species name refer to the page where the species is described; *I* indicates the first section of this paper (Trans. R. Canad. Inst. v. XXVI, 1947), *II* indicates the second section (*ibid.*, v. XXVII, 1948), *III* the section immediately preceding this key.

A. Carapace not attached to the dorsal portion of the posterior thoracic segments.
Order MYSIDACEA

B. With gills on the bases of the thoracic legs; without a statocyst in the inner uropod. (Pleopods unmodified; seven pairs of oostegites.)

C. Carapace bearing several long spines; second to seventh thoracic legs uniform.
Gnathophausia gigas Will.-Suhm (I : 357)

CC. Carapace spineless, second to fourth thoracic legs short and subchelate, fifth to seventh thoracic legs elongate and subchelate; eighth thoracic legs elongate but not subchelate.
Eucopia unguiculata (Will.-Suhm) (I : 359)

BB. Without gills; with a statocyst in the inner uropod that is usually well developed. (Pleopods and oostegites various.)

C. Labrum with bilateral symmetry and not greatly enlarged.

D. Third thoracic legs not developed for grasping but similar to the following legs.

E. Telson distally cleft.

F. Outer margin of squame smooth, without serrations or setae.

G. Squame longer than the antennular peduncle; emargination of the telson not located between two heavy spines, although the tips of the telson may bear spines. (Seven pairs of oostegites; both male and female pleopods biramous, with only first endopodite of the male reduced.)
Boreomysis (I : 361)

H. With cornea hemispherical and entire eyestalk 1.5 to 2.0 times as long as broad.

I. Squame 4 times as long as broad; terminal emargination of telson "U" shaped.
B. kincaidi Banner (I : 362)

II. Squame 3 times as long as broad; terminal emargination of telson "V"-shaped, with an expansion at apex that gives the appearance of a "hole".
B. microps G. O. Sars (I : 365)

HH. With cornea laterally expanded and dorsoventrally compressed so that the entire peduncle is scarcely longer than broad.

B. californica Ortmann (I : 367)

GG. Squame reaching to end of second antennular article; distal portion of telson flanked by two very strong spines. (Two pairs of oostegites, the anterior reduced, and the posterior reinforced by the pleura of the abdominal segments; both male and female pleopods biramous, but some reduced in size and articulations.)

Archaeomysis grebnitzkii Czern. (I : 370)

FF. Outer margin of squame with a series of large teeth. (Three pairs of oostegites; both male and female pleopods uniramous and reduced.)

Inusitatomysis sp. (II : 67)

FFF. Outer margin of squame bearing setae.

G. Squame twice as long as the antennular peduncle. (Two pairs of oostegites; female pleopods rudimentary; first, second, fifth pleopods of male rudimentary, and third and fourth pleopods biramous.)

Mysis oculata (Fabricius) (II : 72)

GG. Squame 1.3 times as long as the antennular peduncle. (Two pairs of oostegites; males with only the fourth pleopods biramous, with endopodite of one article, exopodite of three articles.)

Pugetomysis litoralis Banner (II : 105)

EE. Distal end of telson not cleft.

F. Eyes with visual elements lacking. (Three pairs of oostegites; female pleopods rudimentary; males with four posterior pleopods well developed and biramous.)

G. Eyes united to form a single broad plate.

Pseudomma (I : 380)

H. Inner portion of squame extending considerably beyond its lateral distal tooth.

P. truncatum Smith (I : 380)

HH. Inner portion of squame not extending beyond its lateral distal tooth.

P. berkeleyi Tattersall (I : 381)

GG. Eyes separate, flattened into plates, each carrying a dentate process.

Amblyops abbreviata (M. Sars) (I : 382)

FF. Eyes with visual elements present.

G. Eyes with the cornea separated into two portions. (Sexually differentiated parts as in *F* immediately above.)

H. Body covered with numerous long spines.

Caesaromysis vanclevei Banner (I : 389)

HH. Body without spines.

I. Squame with outer margin straight and without setae, armed with a terminal tooth.

Euchaetomera tenuis G. O. Sars (I : 383)

II. Squame with outer margin setose, slightly curved and without a terminal tooth.

Euchaetomeropsis pacifica Banner (I : 386)

GG. Eyes various, but not bilobate.

H. Lateral margin of squame without setae.

I. Squame reduced in size, shorter than the antennular peduncle. (Sexually differentiated parts as in *F* above.)

Katerythrops sp. (I : 379)

II. Squame longer than the antennular peduncle.

J. Lateral margins of telson unarmed. (Sexually differentiated parts as in *F* above.)

Meterythrops robusta Smith (I : 377)

JJ. Distal two-thirds of the lateral margins of telson bearing numerous spines. (Three pairs of oostegites; fourth pleopods of male with endopodite elongate, other pleopods normal; female pleopods rudimentary.)

Holmesiella anomala Ortmann (I : 395)

HH. Lateral margin of squame bearing setae.

I. Three pairs of oostegites in the females; males with third and fourth pleopods biramous.

Stilomysis grandis (Göes) (II : 70)

II. Two pairs of oostegites in the females; only fourth pleopods of males biramous.

J. Squame elongate with tip narrowly acute. (Two articles in exopodite of fourth pleopod of male.)

Neomysis (II : 73)

K. Distal half of lateral margins of telson bearing about 6-12 pairs of spines.

L. Telson short, twice as long as broad, apex broadly truncate; distal half of margins bearing about 6 pairs of spines. (Proximal article of fourth pleopods of male four times as long as distal article.)

N. mercedis Holmes (II : 75)

LL. Telson long, 2.5 times as long as broad, with apex narrowly truncate; distal half of margins bearing 10-12 pairs of spines. (Proximal article of fourth pleopods of male 3 to 9 times length of distal.)

N. rayii (Murdoch) (II : 78)

KK. Distal half of lateral margins of telson bearing 20 or more pairs of long spines; tip narrowly truncate, almost rounded. (Proximal article of fourth pleopods of males 2 to 4 times length of distal.)

N. kadiakensis (Ortmann II : 82)

JJ. Squame with tip rounded. (Fourth pleopods of male in *Acanthomysis* as in *J* above, in *Proneomysis* biramous but with exopodite of three articles.)

Acanthomysis (II : 83) and *Proneomysis* (II : 102)

K. Abdomen without transverse folds.

L. Apex of telson armed with numerous uniform spines.

M. Squame narrow and elongate, 15 times as long as broad. (Proximal article of exopodite of fourth pleopods 2.5 times length of distal article.)

A. columbiae (Tattersall) (II : 88)

MM. Squame shorter and broader.

N. Squame reaching beyond middle of third antennular article. (Exopodite of fourth pleopod heavy and curved, articulations indistinct.)

A. pseudomacropsis (Tattersall) (II : 89)

NN. Squame reaching only to end of second antennular article. (Exopodite of fourth pleopods normal, with proximal article 10 times length of distal article).

A. macropsis (Tattersall) (II : 91)

LL. Apex of telson with one or two pairs of large spines.

M. Apex of telson with two pairs of large spines. (Exopodite of fourth pleopods with proximal article twice length of distal article.)

A. sculpta var. *nuda* Banner (II : 100)

MM. Apex of telson armed with one pair of moderately large spines.

N. Eyes with corneae dorsoventrally compressed; squame longer than antennular peduncles. (Exopodite of fourth

pleopods with proximal article almost six times length of distal article.)
A. nephrophthalma Banner (II : 93)

NN. Eyes with corneae almost hemispherical; squame shorter than antennular peduncle. (Exopodite of fourth pleopods composed of three articles. Fifth pleopod almost equal in length to the fourth pleopods, but without articulations.)
Proneomysis wailesi Tattersall (II : 103)

KK. Abdomen with transverse folds and ridges.

L. Tip of telson armed with two pairs of large spines on a broad terminal truncation. (See *A. sculpta* var. *nuda*, above.)
A. sculpta (Tattersall) (II : 97)

LL. Tip of telson very narrow, protruding considerably beyond the final pair of large lateral spines. (Proximal article of exopodite of fourth pleopods almost five times the length of distal article.)
A. davisi Banner (II : 95)

LLL. Tip of telson rounded, with closely-set uniform short spines. (Only immature specimens known.)
A. species (II : 101)

DD. Third thoracic legs strongly developed, modified for grasping. (Two pairs of oostegites; all pleopods of both sexes reduced to simple undivided plates.)
Heteromysis odontops Walker (II : 107)

CC. Labrum produced into a large flat plate that is posteriorly divided into two unequal lappets; mandibles without teeth. (Three pairs of oostegites; both male and female pleopods reduced to simple undivided plates.)
Mysidella americana Banner (II : 109)

AA. Carapace coalescing dorsally with all thoracic segments.
Order EUPHAUSIACEA

B. Endopodite of eighth thoracic legs composed of five articles.
Bentheuphausia amblyops (Sars) (III : 7)

BB. Endopodite of eighth thoracic legs either a setose lobe or wanting.

C. Endopodite of seventh thoracic legs composed of five articles.

D. Without dorsal spines on abdomen.
Thysanopoda (III : 9)

E. Carapace without a well-developed cervical groove.
T. dubia Banner (III : 9)

EE. Carapace with a well-developed cervical groove.
(?) *T. cornuta* Illig (III : 13)

DD. With spines on the third to sixth abdominal segments.
Nematobrachion flexipes (Ortmann) (III : 15)

CC. Endopodite of seventh thoracic legs composed of at most two articles.

D. Rostrum always present, elongate, and either flat or dorsally keeled; second thoracic legs elongate or not.
Thysanoessa (III : 17)

E. Without either spines or keels on abdominal segments; carapace with lateral denticle; eyes unconstricted; thoracic legs not elongate.
T. raschii (M. Sars) (III : 27)

EE. Abdomen with either spines or keels; carapace, eyes and legs variable.

F. Lateral margins of carapace without a denticle.

G. Fourth to sixth abdominal segments carrying spines, with that of the fourth the largest; eyes round; none of thoracic legs elongate.
T. spinifera Holmes (III : 18)

GG. Sixth and sometimes the fifth abdominal segments bearing a dorsal posterior spine; eyes and legs variable.
T. inermis (Krøyer) (III : 21)

FF. Margin of carapace with a denticle of varying size located in the posterior half; second thoracic legs elongate; eyes with a transverse constriction; spines of abdomen variable.
T. longipes Brandt (III : 21)

DD. Rostrum, if present and elongate, either "v"-shaped or thin and laterally compressed. Legs various.

E. Eyes hemispherical, without constriction; without elongate thoracic legs. Without rostrum.
Euphausia pacifica Hansen (III : 33)

EE. Eyes with a transverse constriction; at least one pair of thoracic legs elongate.

F. Sixth thoracic legs with full number of articles.

G. Anterior margin of carapace behind eyes not upstanding as a pronounced collar; second thoracic legs elongate. Rostrum variable.
Nematoscelis difficilis Hansen (III : 29)

GG. Anterior margin of carapace behind eyes produced into an upstanding collar; without rostrum; second and third thoracic legs elongate.

Tessarabrachion oculatum Hansen (III : 32)

FF. Sixth thoracic legs composed of three articles or less, third thoracic legs elongate.

Stylocheiron (III : 36)

G. Rostrum present or not, but when present, very slight; third thoracic legs not chelate but bearing numerous distal spines; eyes very high and narrow.

S. longicorne Sars (III : 37)

GG. Rostrum long and deeply "v"-shaped; third thoracic legs bearing a "true" chela; eyes large and broad.

S. maximum Hansen (III : 39)

PLATE I

Bentheuphausia amblyops (G. O. Sars)

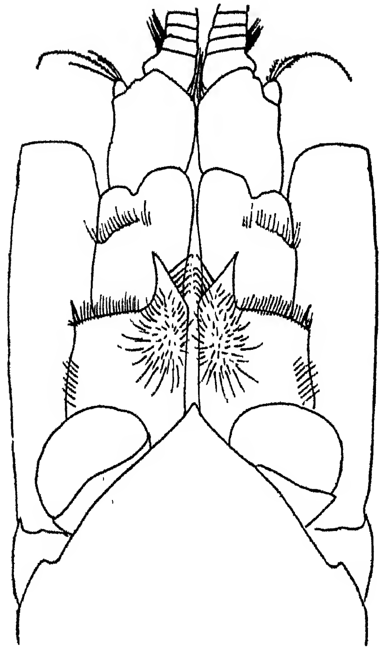
19	Anterior region, dorsal view	Scale A

Thysanopoda dubia species nov.

20a	Anterior region, dorsal view	Scale B
20b	Anterior region, lateral view	Scale C
20c	Maxillule	Scale D

end. . . . . .Endopodite
p ex. . . . . .Pseudexopodite
p 1. . . . . First article of protopodite or precoxa
p 1 e. . . . . Endite of precoxa
p 2. . . . . Second article of protopodite or coxa
p 3. . . . . .Third article of protopodite or basipodite

PLATE I



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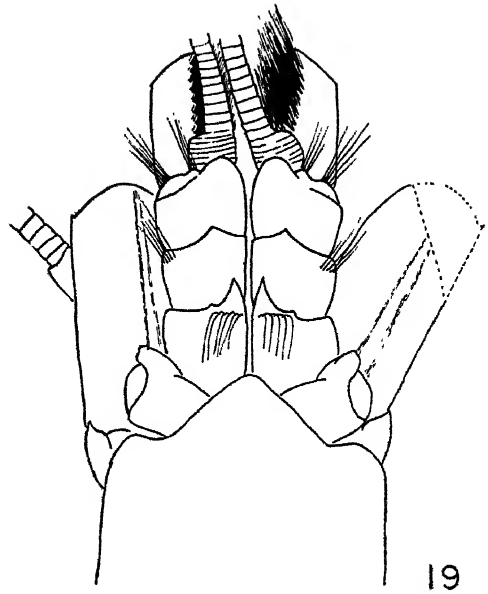

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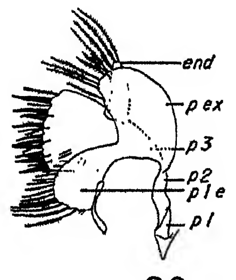

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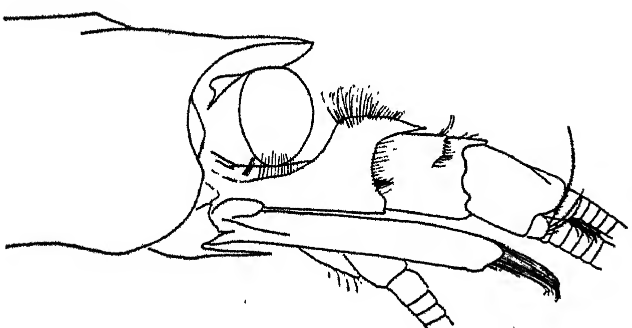


20b

A 1.mm
B 1.mm
C 1.mm
D 0.5mm

PLATE II

Thysanopoda dubia species nov.

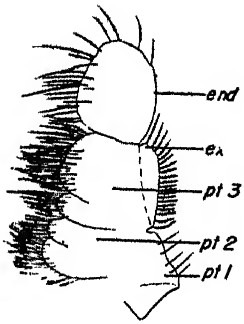
20d	Maxilla	Scale A
20e	First thoracic leg	Scale B
20f	Second thoracic leg	Scale B
20g	Dactylus of second thoracic legs	Scale C
20h	Scythe-spines of second thoracic legs	Scale D

Thysanoessa spinifera Holmes

21a	Seventh thoracic leg of 28 mm. female, gills not shown	Scale E
21b	Seventh thoracic leg of 15 mm. female, gills not shown	Scale E
21c	Copulatory organs of first pleopod of male	Scale E
21d	Proximal and terminal processes from different aspect	Scale E

c............ Carpus
da............ Dactylus
end............ Endopodite
ex............ Exopodite
i............ Ischium
il............ Inner lobe
m............ Merus
ml............ Middle lobe
p1............ Spine-shaped process
p2............ Terminal process
p3............ Proximal process
p4............ Lateral process
p5............ Accessory process
pr............ Propodus
pt............ Protopodite
pt 1............ Precoxa
pt 2............ Coxa
pt 3............ Basis

PLATE II



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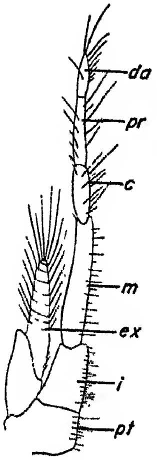

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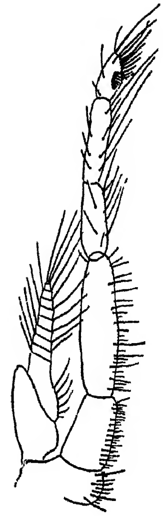

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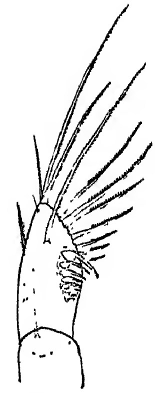

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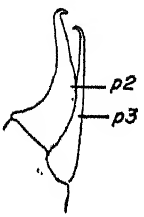

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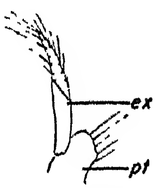
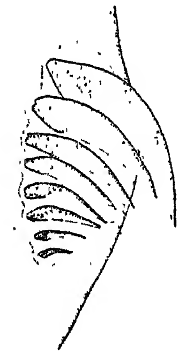
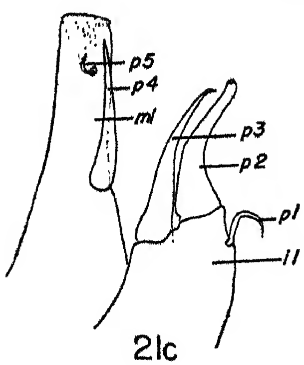


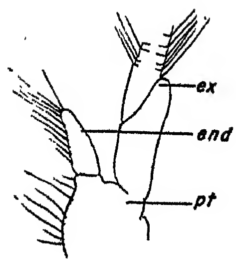
21b



20h



21c



21a

A 0.5mm
B 1. mm
C 0.4mm
D 0.1mm
E 1. mm

PLATE III

Thysanoessa raschii (M. Sars)

22a	Copulatory organ of first pleopod of male.	. . Scale A
22b	Terminal process.	. Scale B

Thysanoessa inermis (Krøyer)

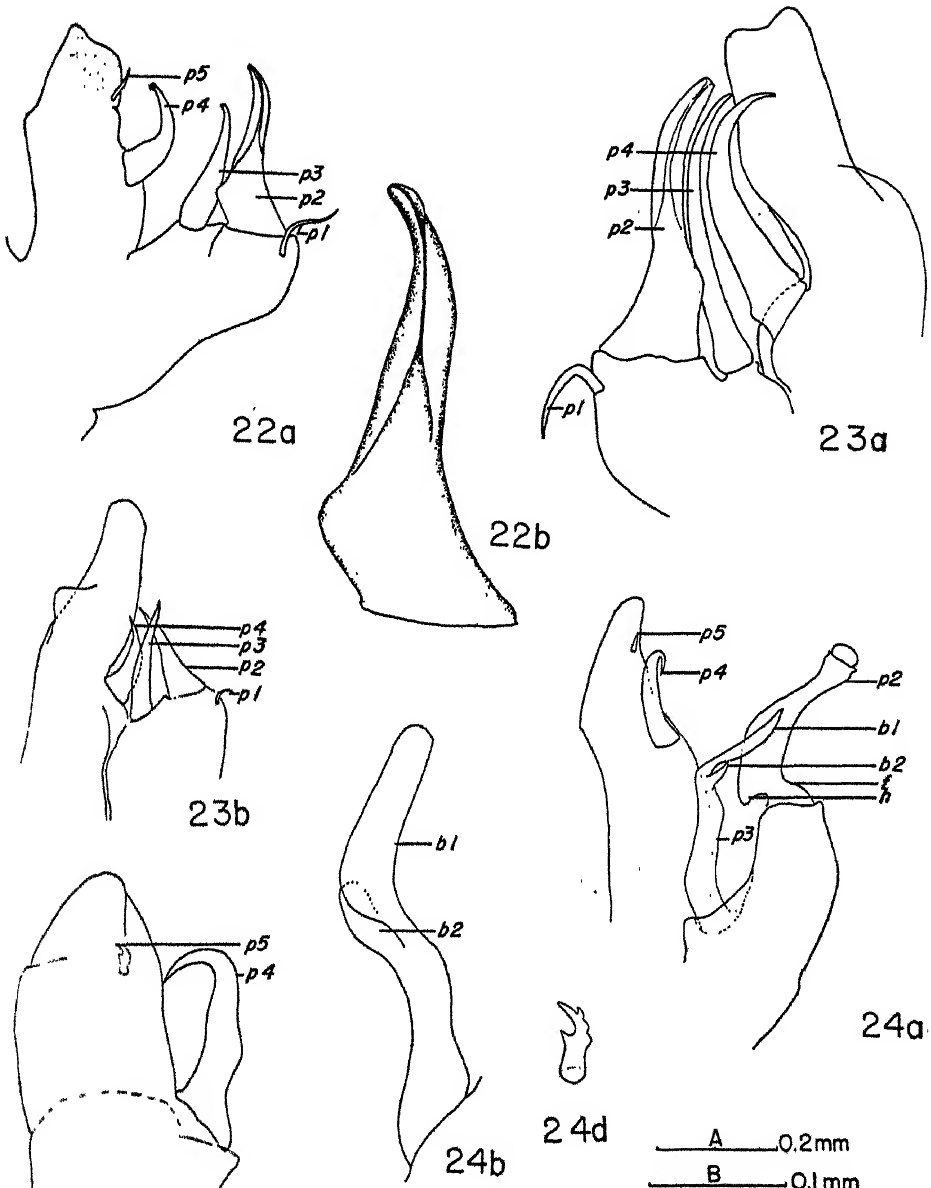
23a	Copulatory organs of a 15 mm. mature male.	Scale C
23b	Copulatory organs of a 20 mm. immature male.	. . Scale C

Euphausia pacifica Hansen

24a	Copulatory organ of first pleopod of male.	. . . Scale A
24b	Proximal process, a different specimen.	Scale C
24c	Middle lobe, a third specimen.	. Scale C
24d	Complex accessory process, enlarged from 24c.	2.3 times Scale C

b1.	Primary blade
b2.	Secondary blade
f.	Foot
h.	Heel
p1.	Spine-shaped process
p2.	Terminal process
p3.	Proximal process
p4.	Lateral process
p5.	Accessory process

PLATE III



p5
p4
p3
p2
p1
22a
22b
23a
23b
24a
24b
24c
24d
b1
b2
f
h
A 0.2mm
B 0.1mm
C 0.1mm

PLATE IV

Stylocheiron longicorne Sars

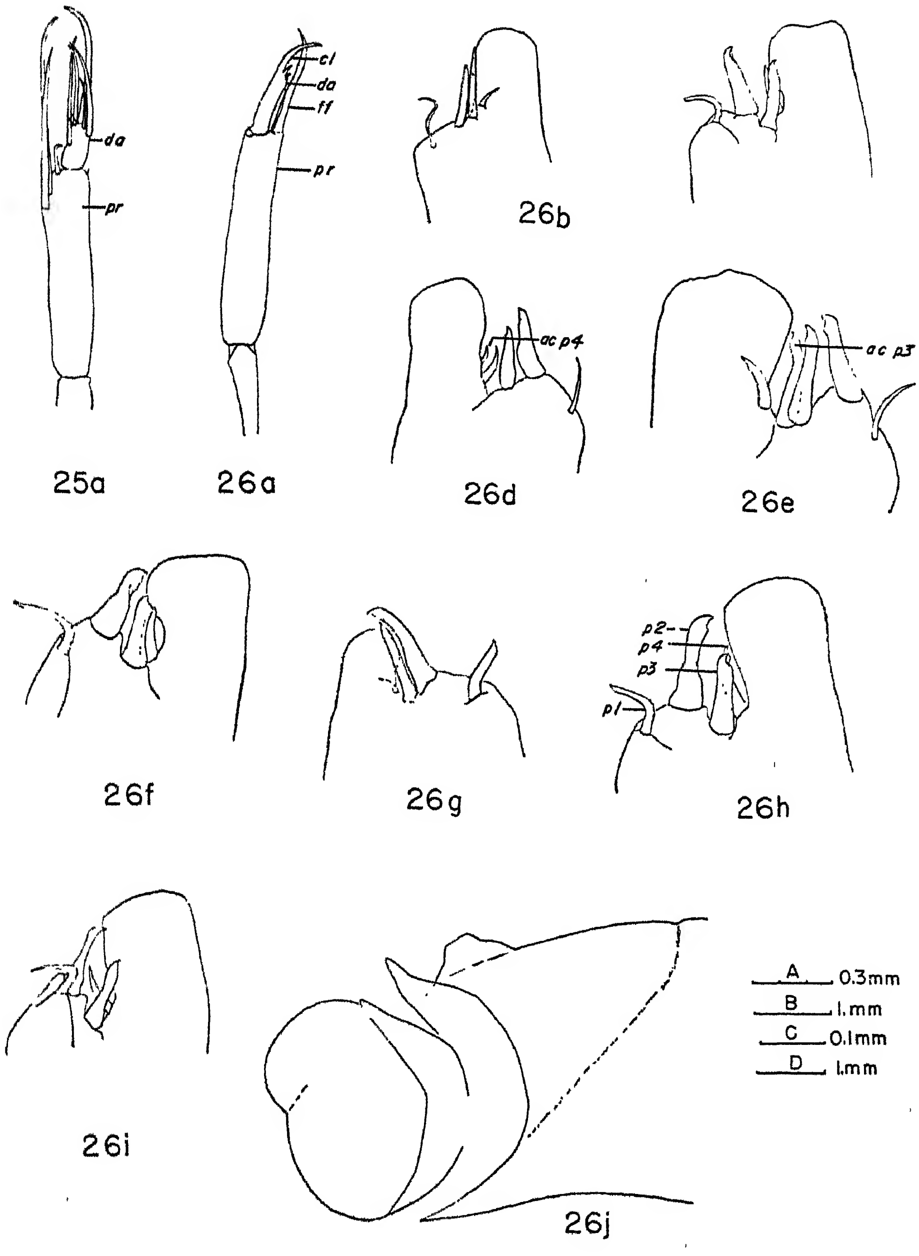
25a	End of third thoracic legs	Scale A

Stylocheiron maximum Hansen

26a	End of third thoracic legs	Scale B
26b	Copulatory organs of specimen from IFC 189a	Scale C
26c	" " " " " IFC 1293a	Scale C
26d	" " " " " IFC 239c	Scale C
26e	" " " " " IFC 429a	Scale C
26f	" " " " " IFC 239	Scale C
26g	" " " " " IFC 2056c	Scale C
26h	" " " " " IFC 622b	Scale C
26i	" " " " " IFC 293a	Scale C
26j	Anterior region of specimen from IFC 2056c, showing aberrant rostrum	Scale D

cl. . . . . End claw
da. . . . . Dactylus
ff. . . . . Fixed finger of chela
pr. . . . . Propodus
p1. . . . . Spine-shaped process
p2. . . . . Terminal process
p3. . . . . Proximal process
p4. . . . . Lateral process
ac p3. . . . . Accessory proximal process
ac p4. . . . . Accessory lateral process

PLATE IV



da
pr
cl
da
ff
pr
ac p4
ac p3
p2
p4
p3
p1
25a
26a
26b
26d
26e
26f
26g
26h
26i
26j
A 0.3mm
B 1.mm
C 0.1mm
D 1.mm

SETTLEMENT OF THE NIPISSING PASSAGEWAY[1]

George R. Rumney[2]

Introduction

Exploration, discovery and settlement in North America have been profoundly affected by the location of lakes and rivers, among the most important of which are the Great Lakes and the St. Lawrence. Early in the 17th century, the French, who occupied the St. Lawrence Valley, discovered a practicable route to the Great Lakes. It led from the St. Lawrence up the Ottawa River to the Mattawa, up the Mattawa to Lake Nipissing, across Lake Nipissing and down the French River to Georgian Bay (Fig. 1). For over two hundred years, explorers, missionaries, and fur traders travelled this route to the west. In time, however, with the discovery of other routes and new modes of travel, it declined in importance, and by 1825 was nearly deserted.

The Canadian Shield, through which the historic highway passed, remained a barrier to the northward spread of settlement for many years after the route had ceased to be important. The shores of Lake Nipissing and of the Mattawa and French Rivers—the Nipissing Passageway—had failed to attract the thousands of early western travellers who saw them. After 1825 two small Hudson's Bay posts at Mattawa and Sturgeon Falls were the only centers of population. At last, toward the end of the nineteenth century, when lumbering and the building of a trans-Canada railroad attracted large numbers of men into the northland, enduring colonization within the region began, and by about 1880 the present pattern of farms, villages, towns, and roads had begun to form in the area.

The story of this colonization, in a land that had for nearly three hundred years resisted the encroachment of settlements, is told in the pages that follow.

Before the first French colonists came to North America, fishermen from France and Portugal regularly crossed the Atlantic to the shores of Canada. Normans and Bretons controlled the fishing grounds in the Gulf of St. Lawrence, where there were rich harvests of cod-fish, seal, and walrus. During the long summer season, on their frequent visits ashore to find food and repair their vessels, the French sailors encountered Indians, from whom they obtained maize, some stone implements, and

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[1] A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at the University of Michigan.

[2] Assistant Professor of Geography, University of Connecticut.

a quantity of furs, in exchange for a few glass beads, some cloth, or a steel knife. The white men learned, on their return to France, that the furs they had bought so cheaply could be sold at a profit among their countrymen. And the Indians, anxious to obtain more of the white man's trifles, assured the Frenchmen that great numbers of fur-bearing animals could be found along the lakes and rivers of the western forests. In this way Indians and white men began a profitable trade in furs which was destined to spread westward and to affect profoundly the course of North American history.

Fur traders came to the Gulf of St. Lawrence, and with them explorers, missionaries, and colonists to occupy the land for France. Fortified posts were established, the first of which was Tadoussac, built in 1600 at the mouth of the Saguenay. Later, as the number of adventurers to New France increased, the principal fur post was moved up the St. Lawrence to Trois Rivières and then to La Chine, on the island of Montreal.

From their remote sources each spring, the tributaries of the St. Lawrence bore canoeloads of Indian hunters to the trading posts, with piles of beaverskins, and otter, marten, and muskrat furs. Down the Ottawa came Hurons, Nipissings, Ottawas, and other Algonquin tribes who hunted near the shores of Georgian Bay and Lake Huron. For these tribes the Ottawa-Nipissing route was the shortest and least dangerous between the Great Lakes and the St. Lawrence. Southward there were passages less difficult, though longer, that were known to the northern tribes, but the savage attacks of their enemies, the Iroquois, who lived on the shores of Lake Ontario, had made it unsafe to travel them.

It was from the northern tribes that Samuel de Champlain, arriving in New France in 1603 to search for a passage to China, heard of the upper St. Lawrence, the headwaters of the Ottawa, and a great western sea. Little was known of interior North America at this time, and Champlain resolved to set out as soon as possible for the west, and explore the Ottawa to its source.

It was not until 1610, however, that the first white man ventured to travel up the Ottawa. In June of that year, according to Champlain, a youth, Étienne Brulé, went with a band of Hurons who were returning to their hunting grounds. Brulé has left us no account of his travels, but we may assume from Champlain's record that he went up the river of the Ottawas, which was then known as La Grande Rivière, and crossed by Lake Nipissing to Georgian Bay.[1]

[1]Butterfield, C. A., *History of Brulé's Discoveries and Explorations*, 1610-1626, Cleveland, 1898, pp. 15-20.

Five years later, in 1615, Champlain, with a small group of Frenchmen and the Recollet, Joseph LeCaron, joined a party of Hurons to follow the path of Brulé.[1] The written record of his observations and his map of 1632 provide the earliest account of travel up the Ottawa and across Lake Nipissing to the Great Lakes.

The Mattawa River, Lake Nipissing, and the French River, and their wooded shores, connect the River of the Ottawas with the Lake of the Hurons. This was the Nipissing Passageway (Fig. 1). With the Ottawa River it formed a canoe route between east and west that was travelled by missionaries, fur traders, and explorers for over 200 years.

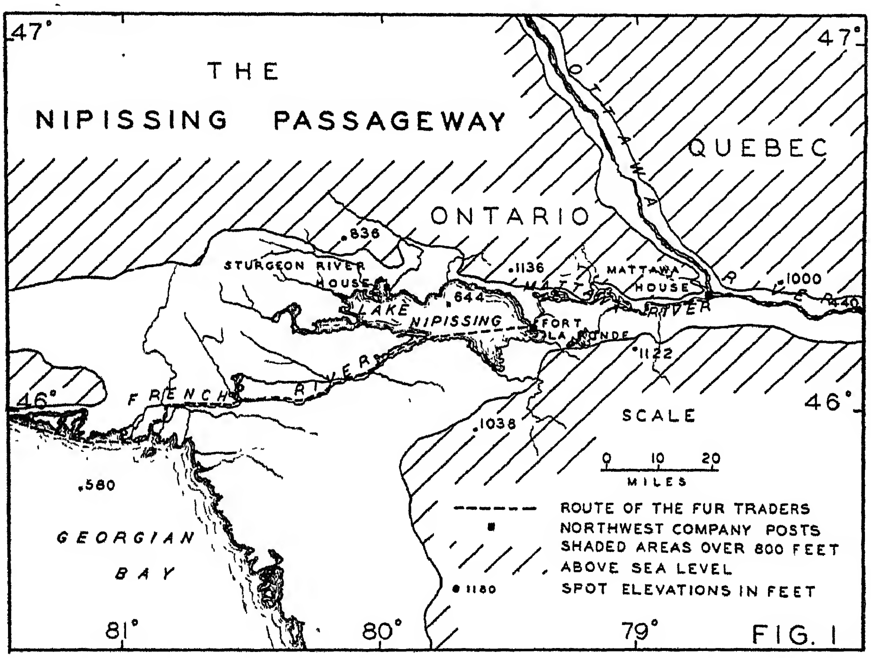

FIG. 1

Settlement of the Nipissing Passageway began slowly. Of the numerous traders and missionaries who passed along its lakes and rivers, few were attracted to the land. By 1763, when French rule in Canada ended, not a single white man's cabin could be found, and only a few Indian families were living along the shores of Lake Nipissing and the French River.

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[1]Biggar, H. P., *The Works of Samuel de Champlain,* Toronto, The Champlain Society, 1922, Vol. II, passim. Champlain made his first voyage up the Ottawa in 1613 as far as the present town of Pembroke. Discouraged by the Indians from going farther, he turned back.

Trading posts appeared for the first time in the Nipissing Area after 1783 when the Northwest Company, with headquarters at Montreal, was formed. Two of the posts endured and eventually became the foci of settlements which were later developed into the villages of Mattawa and Sturgeon Falls. As the fur trade expanded across the continent, however, the Northwest Company found itself unable to compete successfully with the Hudson's Bay Company that had been trading in furs for more than a century from its base at York Factory on Hudson's Bay. In 1821 the Northwest Company merged with the Hudson's Bay Company, and control of the fur trade in Canada was shifted to York Factory.

By 1825 Montreal had lost its importance as a fur depot, and the Ottawa-Nipissing canoe route became all but deserted. For thirty years a few Hudson's Bay Company canoes, sent to accommodate the diminished trade of Sturgeon River House and the post at Mattawa, brought the only regular travellers into the Nipissing Passageway.

During this period a new enterprise began to develop on the Ottawa. Timber was needed in Great Britain for ships, and the vast pine forests of northern Ontario and Quebec could amply supply the demand. As lumbering progressed in the Nipissing Passageway, a few settlers, assured of a ready market for the products of their farms, began taking up land in the Mattawa Valley. Thus the beginnings of agricultural settlement in the Nipissing Passageway were made under the influence of the lumbering industry.

However, in 1871 the Dominion census showed only 100 people living in the Nipissing Area, all in the vicinity of Mattawa. A new stimulus was needed to encourage migration from the fertile fields of southern Ontario into the northland of rock hills, forests, lakes, and rivers. It appeared in the form of two colonization roads, which, under the Dominion Land Policy, had been slowly stretching into the wilderness for several years. One of them, extending northward from the town of Rosseau on Rosseau Lake, had reached the village of Nipissing on the South River in 1871.

In 1875 another narrow wagon trail was completed to Mattawa, winding along the hilly banks of the Ottawa from the town of Pembroke. Still, for many years, the lands beyond Mattawa and Nipissing Village remained unclaimed by all but a few hardy pioneers.

Meanwhile the steel tracks of the Canada Central Railway[1] were advancing along the Ottawa toward the Nipissing Passageway. They reached Mattawa in 1881. A year later the first locomotive to pass

[1]The Canada Central was amalgamated with the Canadian Pacific Railway in 1881. Canada, *Sessional Papers*, 1883, No. 27n, p. 13.

along the shores of Lake Nipissing puffed to a stop at North Bay. By 1883 the rails of the Canadian Pacific had been extended beyond Lake Nipissing and in 1885 they completed the span of the continent. At intervals along the railroad, where construction camps, loading platforms, water towers, and storage sheds were maintained, the log cabins of villages appeared. Thus the first railroad to cross the Nipissing Passageway brought with it many of the present-day settlements.

Other railroads followed, and today two trans-continental lines and a trans-Canada motor highway cross this segment of the historic canoe route. The city of North Bay, the towns of Mattawa and Sturgeon Falls, and numerous rural villages have grown up along them. With the expansion of colonization that followed these beginnings, the present pattern of roads and settlements was developed, and now mixed farming, the cutting of timber for lumber and pulpwood, and an expanding recreation industry are the chief uses of the land.

PHYSICAL SETTING

In eastern Canada, from the frozen Arctic southward to Lake Huron, Lake Ontario, and the St. Lawrence, stretches a vast expanse of Archean rock called the Canadian Shield.[1] It is a region of lakes, rivers, marshes, forests, and thin soils, associated everywhere with rounded hills and ridges of exposed bed rock.

Where the Province of Ontario contracts to its narrowest width, the uneven surface of the Shield is interrupted by a shallow, irregular depression in which lie the lakes and rivers of the Nipissing Passageway. North and south of the Nipissing Passageway the irregular surface of the Canadian Shield rises to an elevation of more than one thousand feet above sea level. The indistinct borders of the enclosing upland are from three to four hundred feet higher than the depression below them. On the map, Figure 1, boundaries are shown between highland and low, based upon the eight hundred foot (conjectural) contour line. It may be observed, from the eastward extension of these boundaries, that the Ottawa Valley forms a continuation of the Nipissing Depression. Thus, between Georgian Bay and the St. Lawrence, a continuous channel may be traced, which is believed by geologists to have been the eastern outlet of an ancient system of lakes called the Nipissing Great Lakes.[2]

The land is rocky, rough, and thinly covered with stony soils. Wherever the roots of trees can obtain nourishment and support, pine, spruce, fir, maple, birch, and poplar are commonly found. The climate in which these plants develop is distinguished by long cold winters, cool summers, and about thirty inches of annual rainfall. The combination of physical elements: drainage, physiography, vegetation, and climate, has had a decided influence on the settlement of the Nipissing Area.

Drainage

The present drainage of the Great Lakes is separated from that of the Ottawa by a low divide between the Vase and the Mattawa Rivers. Into the Mattawa, Lake Nipissing, and the French flow nearly all the waters of the Nipissing Passageway.

The Mattawa, from its source in Trout Lake, follows a winding course among tree-clad hills of gneiss for over forty miles eastward to the Ottawa. For most of its length it is bordered on the north by high green hills that descend steeply to the water's edge, where there is an

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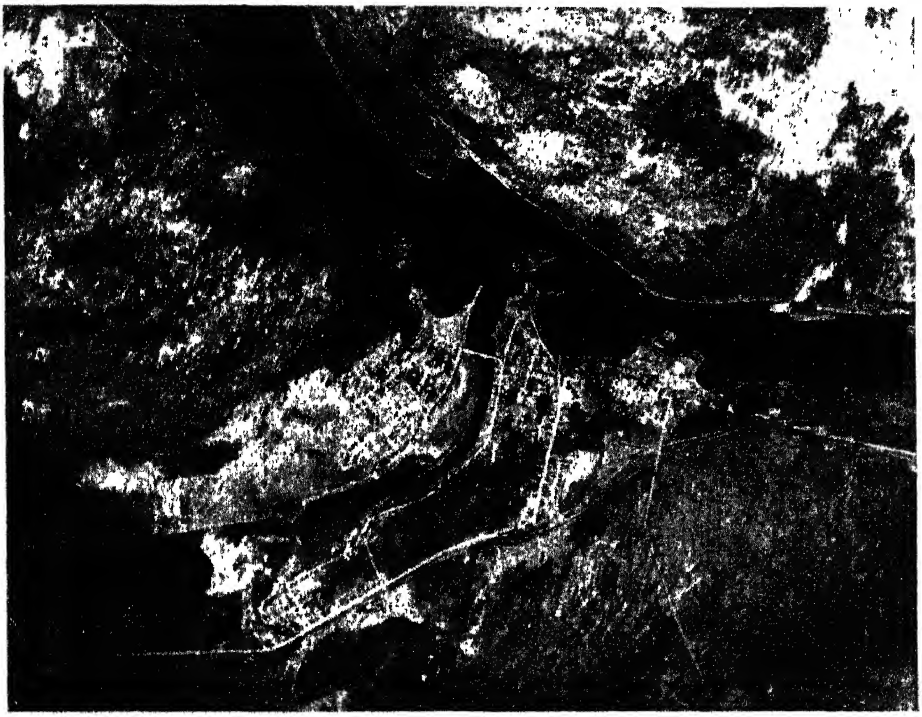
[1]The Laurentian Upland, Laurentian Plateau, Precambrian Shield.

[2]Taylor, F. B., "The Nipissing-Mattawa River, the Outlet of the Nipissing Great Lakes", *American Geologist*, Vol. XX, 1897, pp. 65-66.

intermittent fringe of narrow rocky beaches. The bordering hills to the south are wooded as well, but are lower, and slope more gradually to the water's edge.



R.C.A.F. Photograph

FIG. 2. The town of Mattawa. Junction of Mattawa and Ottawa Rivers at center. Trading post site is on the narrow peninsula projecting into the Ottawa from the left bank of the Mattawa. The main line of the Canadian Pacific may be seen passing south of the town, along the foot of the wooded hills on the lower right. A branch of the railroad passes through town and across the Ottawa, leading toward Lake Temiskaming. North toward top. Scale: about 4 inches to the mile.

The Mattawa is essentially a series of deep clear lakes, connected by narrow rocky channels, in which the water tumbles over rapids or waterfalls. The largest of the lakes is Trout Lake, draining eastward between constricted banks of sloping bed rock into Turtle Lake. From here the Mattawa descends over four miles of intermittent rapids and is joined by the North River before entering the second largest of the lakes, Lake Talon. At the eastern end of Talon, where it is joined by the Kaibuskong River from the south the Mattawa flows in a narrow canyon of

gneiss toward a forty-three foot fall of water called Talon Chute. Below this it expands slightly to form Pimisi Bay and then plunges once more over a long cascade into Bouillon Lake. This is a slender, twelve mile stretch of quiet water which empties over Des Roches, La Rose, and Epine rapids into a similar lake called Lac Plein Chant. Above Les Epines a large tributary, L'Amable du Fond River, joins the Mattawa from the south. For many years Lac Plein Chant has poured its waters over a ten foot power dam into a rocky channel in which the diminished stream flows toward the east. In the last half-mile of its course, the Mattawa curves northward before uniting its waters with the stately flow of the Ottawa (Fig. 2). Thus the Mattawa is fed by three main tributaries—the North River, the Kaibuskong, and L'Amable du Fond, and also by the waters of numerous creeks, like Blueseal, Boom, Patois, and Bouillon. It descends more than 160 feet, from Trout Lake to the Ottawa, over twelve separate cascades.

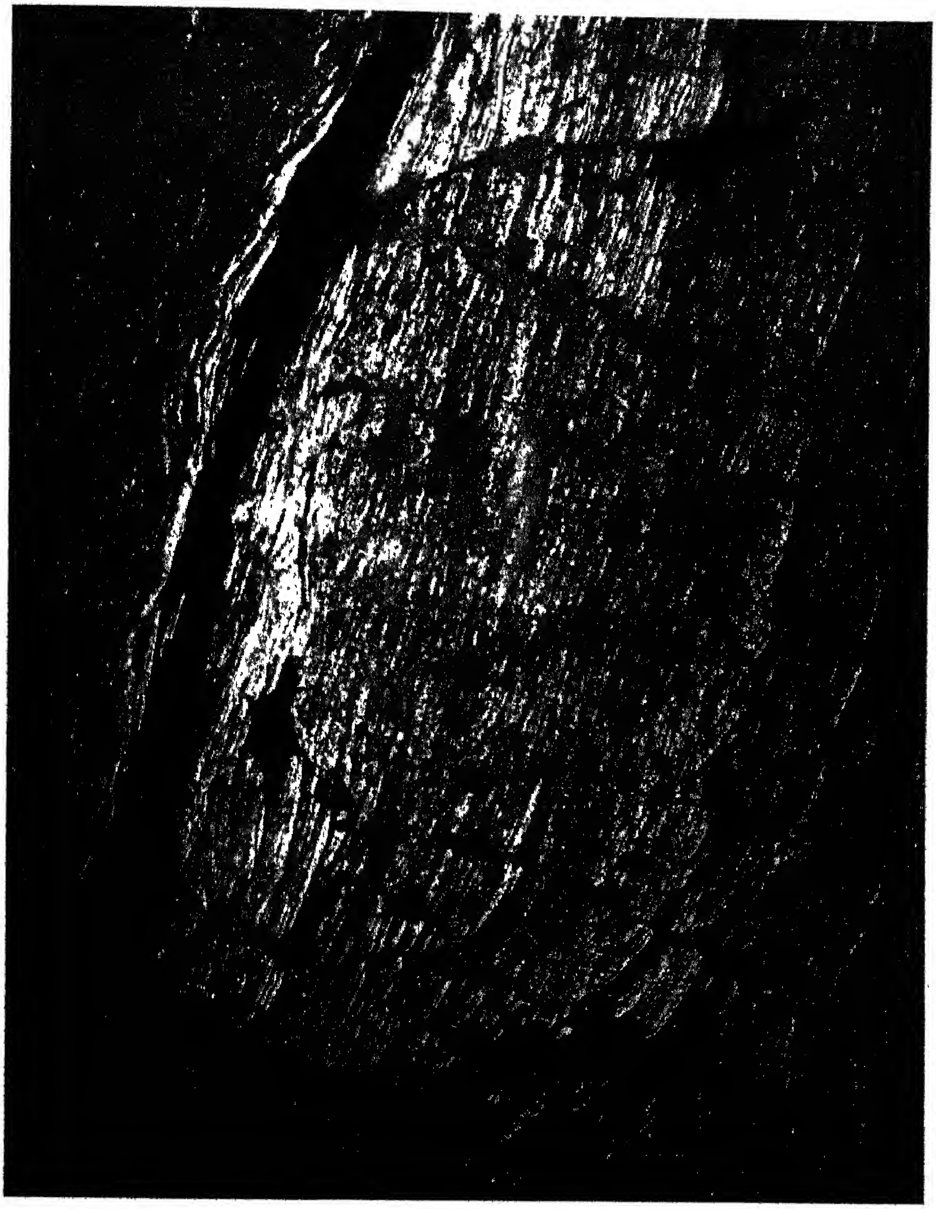
On the rocky banks abreast of each waterfall or rapid, there were, in the fur trade period, narrow portage trails and, in addition, there were often trails through the forest connecting one lake with another.

The portage over the height of land between Trout Lake and Lake Nipissing was the longest and most difficult in the Nipissing Passageway. French fur traders discovered that the most expedient of several trails used by the Indians led from Trout Lake along the marshy waters of La Vase Creek to its mouth.

Lake Nipissing occupies a shallow, irregular basin in the Laurentian bed rock. Its greatest length from east to west is about sixty miles, while from north to south its greatest width is sixteen miles. The northern and eastern banks are lined with sweeping sandy beaches between which are rounded points of bed rock. Its western and southern shores are for the most part bold, rocky, and deeply indented, and are screened in places by clusters of wooded islands. Reed-filled marshes occupy many of the shallow indentations along the western shores.

Lake Nipissing receives the drainage of four large rivers, the South, the Sturgeon, whose source is Lake Timagami, the Veuve, and the Amateewakea, besides the outflow of many small creeks. Chief among these are the Wistawasing, La Vase, Chippewa, La Ronde, Duchesnay, and Little Sturgeon.

Among the wooded islands that screen its southwest shore, the waters of Lake Nipissing pass slowly into the channels of the French River. Over the Chaudière Falls, Five Mile Rapids, Recollet Falls, and Les Dalles the stream gradually descends southwestward to Georgian Bay, sixty feet lower than Lake Nipissing. The land through which it flows is rocky and forested, becoming lower toward its mouth, and there sloping gently beneath the island-dotted waters of Georgian Bay (Fig. 3).



R.C.A.F. Photograph

FIG. 3. Main Channel outlet of the French River. The site of French River Harbor (left center) is along the left bank of the channel. A close inspection will reveal a number of buildings that mark the site. This photograph was taken in 1928. These buildings are no longer standing. The lighter portions of the land area are bedrock ridges, almost bare of vegetation, sloping gradually beneath the waters of Georgian Bay (bottom). North toward top. Scale: about 4 inches to the mile.

The French River is joined from the east by the Restoul, the Pickerel, and several smaller streams. From the north and west flow the Wahnepitei, the Murdock, and the Wolseley. The Pickerel and the Wahnepitei enter the French at Ox Bay, about seven miles upstream from the mouth of the main channel. West of Ox Bay the French River branches into four separate channels through which pours the drainage of nearly all the lands west of the Mattawa.

In addition to the waters of Lake Nipissing, the Mattawa, and the French, and their tributaries, the Nipissing Area is dotted with countless small lakes, ponds, and marshes having no apparent connection with the major drainage features.

Physiography

The uneven, rocky surface of the Nipissing Area is typical of the Canadian Shield. The essential features of this surface are massive knolls and ridges of exposed gneiss and granite, separating depressions of diverse size and form.[1]

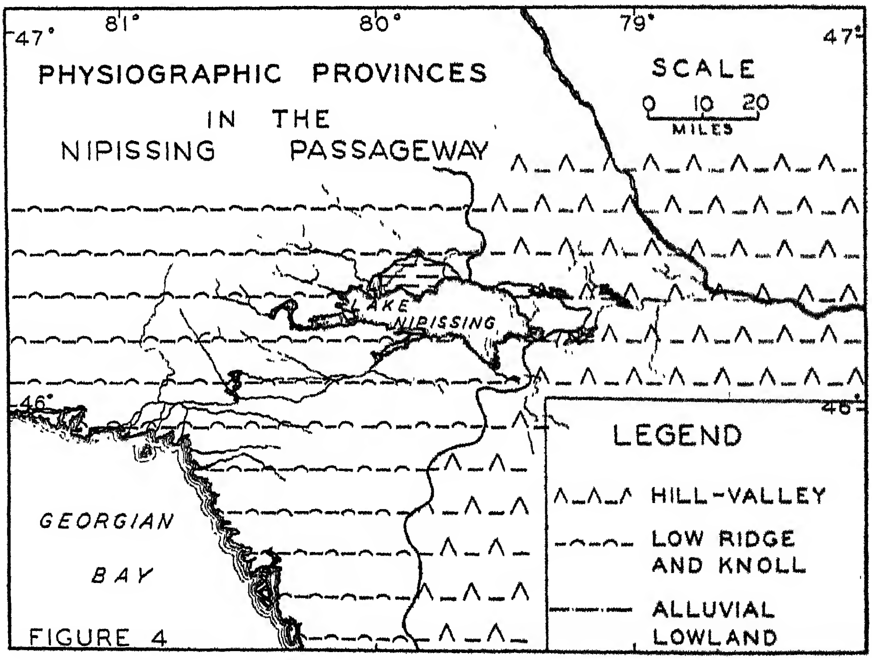
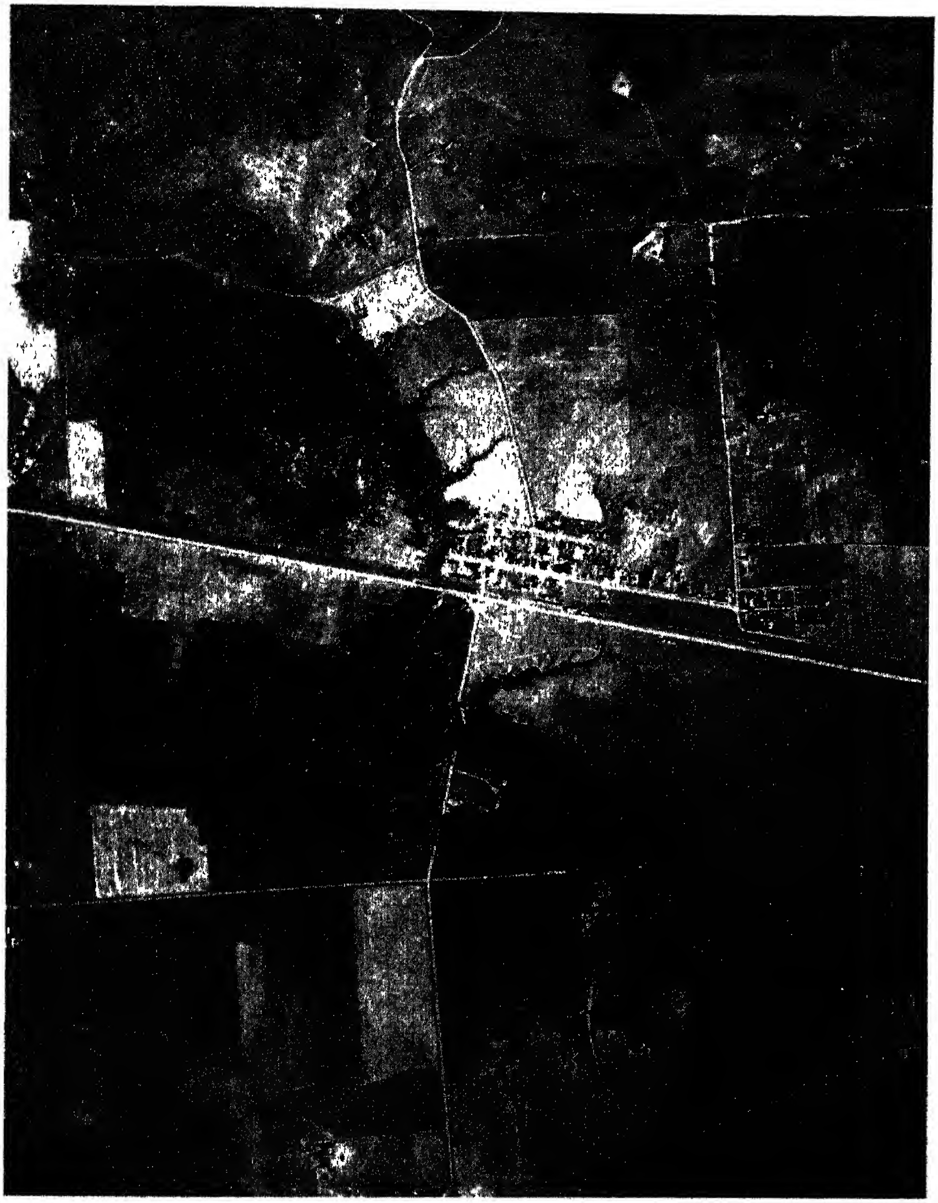


FIGURE 4

[1]Its sculptured nature is the result of two main causes: 1) Fracturing of the crystalline bedrock; 2) Subsequent widening and rounding of the fissures by glaciation. Alfred, W. G., "The Laurentian Peneplain", *Journal of Geology*, Vol. XI, No. 7, Oct.-Nov., 1903, p. 659.



RCAF Photograph

FIG. 5. Village of Warren. The farms here, as at Verner, have been established on deep deposits of varved clays, glacial till, and alluvium. The Canadian Pacific Railroad and the main highway between North Bay and Sault Sainte Marie pass along the southern edge of the village, north of the Veuve River. North toward top. Scale: about 4 inches to the mile.

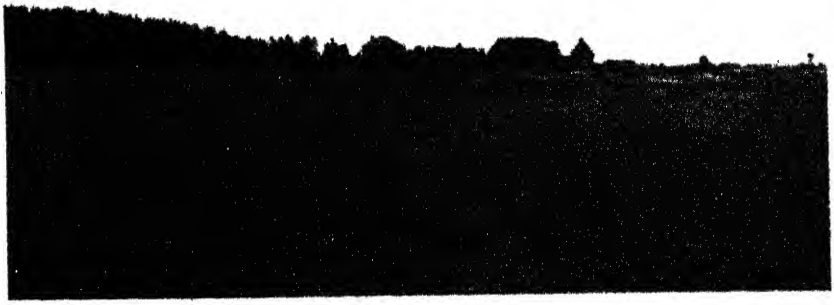
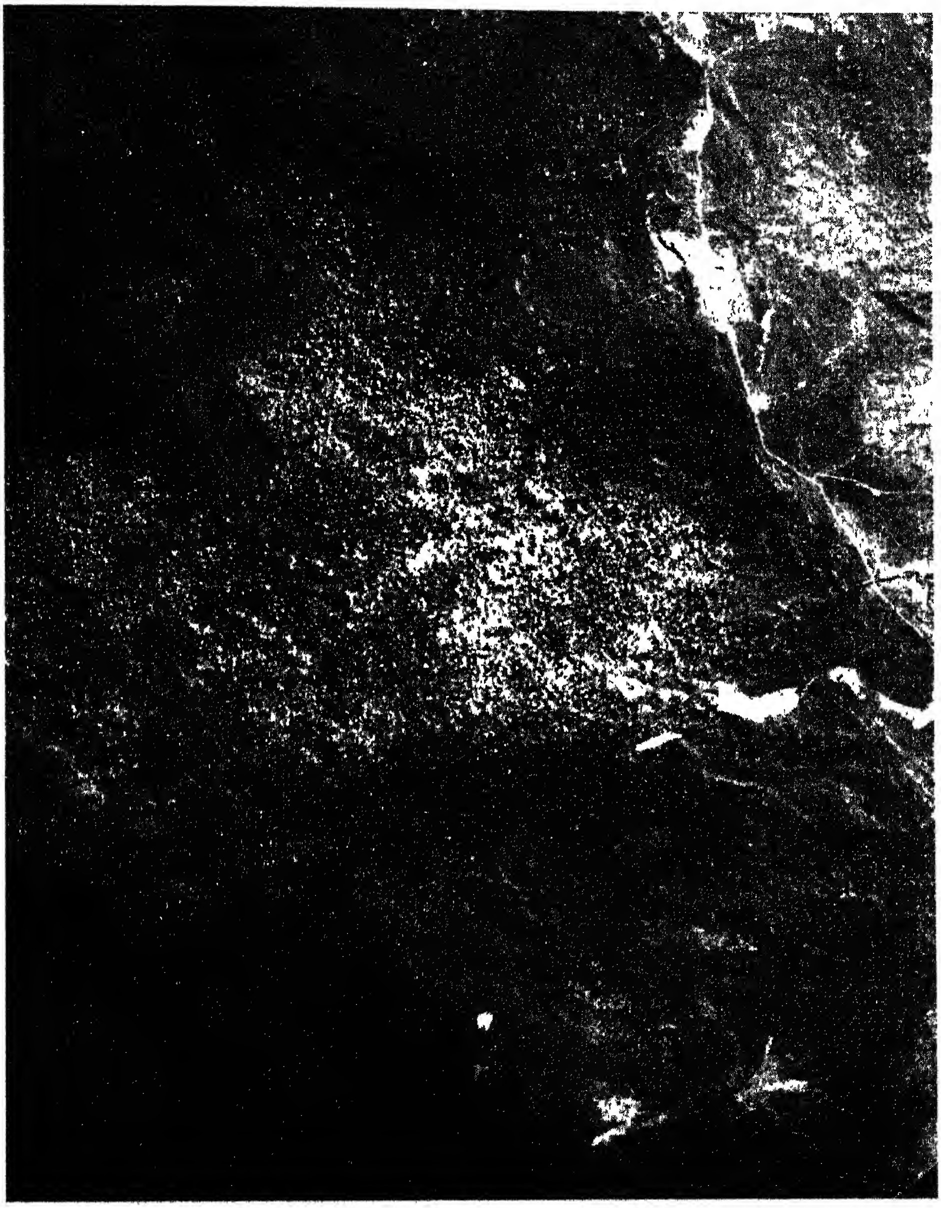


FIG. 6. The well-kept buildings of a productive farm in the St. Charles farming area, about four miles northeast of St. Charles (see Figure 18). Wooded section on the left covers a low ridge of exposed bedrock.

In the Nipissing Passageway three major physiographic divisions are distinguishable: 1) Low Ridge and Knoll; 2) Hill-Valley; 3) Alluvial Lowland. It is evident, Fig. 4, that the Low Ridge and Knoll section is the most widespread, extending over all the lands west and south of Lake Nipissing, and appearing in outliers east and north of it. It is an uneven surface of low relief, distinguished by long rounded ridges and knob-like hills of red and gray banded gneiss and coarsely-crystalline granite. Between the hills and ridges, except where there is water, there are deposits of sand, clay, glacial till, peat, and muck. In many places these deposits extend for several acres, and where other conditions are favorable, they have been cleared for farms (Figs. 5 and 6).

The Hill-Valley area, bordering the Mattawa River, can be recognized by the presence of numerous wooded hills and broad valleys, having a difference in elevation of three to four hundred feet. Gneiss and granite bedrock underlie the surface everywhere. As in the Low Ridge and Knoll province, sand, clay, glacial till, peat, and muck are found here in pockets along the flanks of the hills (Figs. 7, 8, 9).

Extending from the lower reaches of the Sturgeon River is a small expanse of level land enclosed between Lake Nipissing and a low range of hills to the north. This is the Alluvial Lowland, an area of stratified gravel, sand, silt, and clay, reaching eastward from Cache Bay to La Ronde Creek. Most of the land here is poorly drained and is covered with a dense growth of low willows, birches, alders, poplar, spruce, and tamarack. In the vicinity of Sturgeon Falls many parcels of land have



RCAF Photograph

FIG. 7. Wooded hills typical of the Hill-Valley Province north of the Mattawa River. At the right is a tributary of the North River, and to the left of this stream are large, rounded hills, differing conspicuously from those of the Low Ridge and Knoll Province by their greater size and relief, and by the absence of exposed bedrock. Evergreen trees appear as the darker elements in the vegetation. North toward top. Scale: about 4 inches to the mile.

been cleared and drained sufficiently to produce crops, but elsewhere it remains for the most part choked with thickets of low trees and shrubs (Fig. 10).

Over these major physiographic provinces have lain the ice of prehistoric glaciers and the waters of ancient lakes. Scattered everywhere over the broken surface is a mantle of loose rock material, ranging from finely powdered clay to heavy gravel and boulders. These deposits are considered by geologists to be the result of glacial and lacustrine deposition.

Vegetation

From the frozen tundra of Arctic North America, the great coniferous belt of the Taiga reaches southward to the shores of the Great Lakes, and merges in a broad transition zone with the deciduous forests farther south. Spruce, fir, jackpine, and poplar are characteristic throughout the Taiga, while in the lower latitudes of this region are forests of maple, oak, pine and hemlock.

The Nipissing Area lies in the transition zone beween the Taiga and the deciduous forests south of it. The following trees are common to the area: white and red pine, sugar maple, red maple, hemlock, spruce, fir, birch, poplar, and jackpine. White pine, sugar maple, yellow birch, and hemlock tend to predominate over the other species, forming what ecologists call a forest climax.[1] Most of the mature trees in the area have been felled, however, and widespread forest fires have damaged many of the remaining stands. Nearly everywhere, on the cut-over, burned-over land, the fast-growing canoe birch (*Betula papyrifera*), poplar (*Populus tremuloides*), and cherry (*Prunus pennsylvanicum*) have sprung up where other species once grew, and beneath them gradually appear young spruce, fir and pine (Fig. 11).

The present composition of the plant cover consists in general of several distinguishable associations. On the slopes of the hills north of the Mattawa are mature stands of yellow birch and sugar maple. Scattered among them are white pine, hemlock, red oak, and beech, and on the sandy soils are groves of red pines (Fig. 7).

South of the Mattawa most of the original saw-log trees have been removed, and now, stands of immature pines, maples, and birches are found. Here, on the deeper soils, the hardwoods tend to predominate, while the shallow light soils are occupied by nearly pure stands of red and white pine.

In the scattered lowlands east of Lake Nipissing spruce and fir are usually dominant, and, with tamarack, fringe the low, moist borders of many lakes and rivers. On the alluvial borderlands of rivers, red

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[1]Halliday, W. E. D., *A Forest Classification of Canada*, Ottawa, J. O. Patenaude, 1937, p. 31.

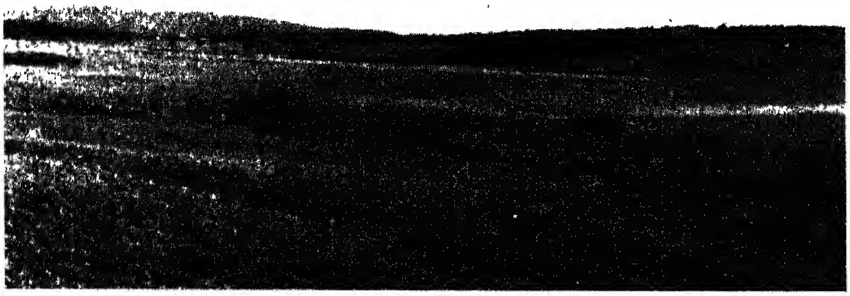

FIG. 8. A shallow, loam-filled valley about two miles southwest of Powassan. South River to the left, in the distance. Although the soils in the valleys of the Powassan farming area (see Figure 18), are generally fertile, those on the upper slopes, as on the right in the picture, are often sandy, and remain untilled pasture land.

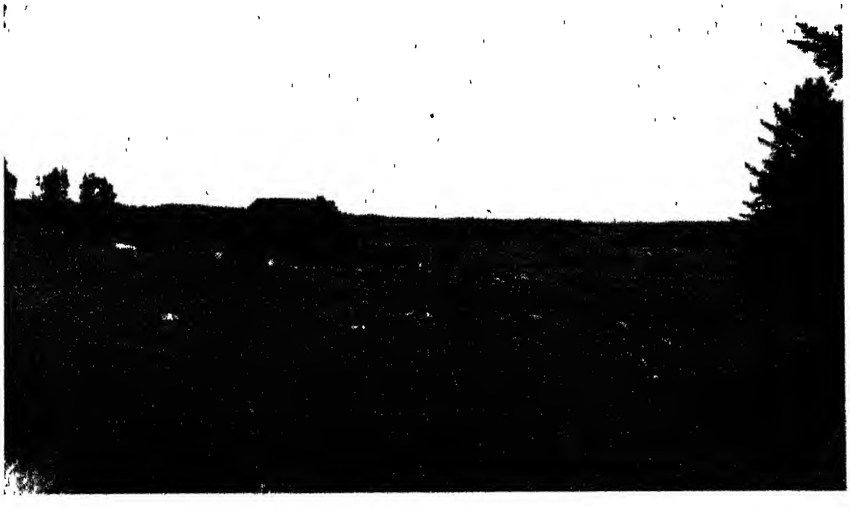

FIG. 9. The buildings and boulder-strewn pasture of a farm about one mile southwest of Corbeil (see Figure 15). It is one of the better farms in this area of relatively low productivity.

maple, black ash, and American elm appear. This association is found in limited areas in the Nipissing Passageway wherever there are wet, low-lying river or lake deposits. For example, on Beaucage Point, along the banks of the lower Sturgeon, and in the valleys of the Veuve and South Rivers, red maple, black ash, and American elm are common.

On the rough surface of the Low Ridge and Knoll province, mixed stands of conifers and hardwoods are associated with the common cover of white birch and aspen. Beneath the tree cover, in the shallow pockets of soil, low juniper, huckleberry, and blueberry bushes grow luxuriantly. Near the mouth of the French River, jackpine is dominant, with a scattering of small birch, poplar, and maple. Fig. 12 shows the distribution of the dominant forest associations.

Many of the low swales in the Nipissing Passageway are covered by dense thickets of alder, willow, birch, and poplar. These moist depressions are frequently filled with cranberry or leatherleaf bushes.

From the above generalizations it is clear that the varied pattern of vegetation in the Nipissing Area is chiefly owing to diverse conditions of soil, drainage, and slope. The presence of its essential elements, however, is due to the influence of climate,- the average conditions of rainfall and temperature over a long period of years.

Climate

The transitional vegetation zone, in which lies the Nipissing Area, reveals the influence of two climatic regions. The climate of the Nipissing Passageway is transitional between that of the Boreal Forest and the deciduous forest region south of it.

Winters are long and cold, with an average temperature for January, the coldest month, of nine degrees Fahrenheit. Summers are short and cool. The warmest month, July, has an average temperature of sixty-five degrees Fahrenheit. The average annual precipitation amounts to thirty inches. The local variations from this general scheme become apparent from a study of Tables I and II. These climatic elements may be summarized in the Köppen classification system by the symbols Dfb.[1]

From November to May, the ground and the frozen surfaces of lakes and rivers are usually white with snow. As much as two feet commonly falls in a single month. Rivers and lakes often become winter highways for motor vehicles and sleighs. Bush trails through the forests are opened to the lumbermen in winter, when shrubs and trees are bare of leaves and the otherwise impassable trails become firmly packed with snow and ice.

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[1]Köppen, W., and Geiger, R., *Handbuch der Klimatologie*, Berlin, Gebrüder Borntraeger, 1938, Band II, Teil J. passim.

RCAF Photograph

FIG. 10. The Sturgeon River near its mouth. Farm clearings typical of the Alluvial Lowland appear in upper portion of picture. Lake Nipissing appears as dark area at bottom, McLeod Bay at left. Site of Sturgeon River House on right bank of the river at bend in upper portion. Fine, light-colored lines in the river are booms to control logs destined for lumber mills at Cache Bay or Callander. North toward top. Scale: about 4 inches to the mile.

FIG. 11. Regeneration of spruce and fir has begun under tall stands of birch and poplar. Photo shows a small expanse of cut-over, burned-over land south of the Mattawa River.

Summer precipitation occurs in the form of thundershowers and long steady rains that last for several days. The heaviest rainfall appears during the growing season, between May and October. The frost-free season varies considerably in length from year to year.[1] The last frost in spring may occur any time between the last week of May and the first week of June. Early frosts in autumn are not unusual, but the first frost normally appears around the middle of September. In some places of high elevation light frosts have been experienced during June and July. Variations from the average conditions are common, (Table III), depending upon the proximity to water, and the general qualities of the land.

In this physical setting the colonization of the Nipissing Passageway has taken place. It is reasonable to suppose that the countless lakes and rivers, the exposed bedrock, the pine, birch, and hemlock forests, and the cold climate have all had an important effect on the progress and present state of settlement.

THE FUR TRADE—1615 TO 1825

The fur trade in the Nipissing Area began in 1715 when Champlain and LeCaron journeyed up the Ottawa and across Lake Nipissing to the Great Lakes. Then, for more than two hundred years, explorers,

[1]Table III shows the record of first and last frosts in the growing season at three stations in the area for the ten-year period from 1930 to 1939.

missionaries and fur traders travelled this route to the west. By the end of the period, in 1825, trading posts had been established, and two of these, at Mattawa and on the Sturgeon River, became the first settlements in the Nipissing Area.

The headquarters of the fur trade was established at Montreal, with the founding of the city in 1641. From Montreal and the main artery of travel up the Ottawa, the French extended a far-reaching network of water highways into the forested region of the Great Lakes and beyond. The French had discovered that the Indian's birch canoe was eminently suited for travel on the lakes and rivers of the rocky, forested hunting grounds to the west, where the light craft could be carried from one lake to another, or past the many waterfalls and rapids that frequently obstructed the flow of rivers. Adventurous coureur-de-bois, and later, Recollet and Jesuit missionaries, adapted themselves to the use of the birch canoe and to the Indian's method of living in the wilderness, as they explored the forests far to the west.

The route of Champlain and LeCaron was shorter than those farther south, and it was safer for two good reasons. First, because it passed northward of the Iroquois country bordering Lake Ontario, and the headwaters of the St. Lawrence, where for many years savage Iroquois war parties had made it dangerous to travel. Second, because its narrow lakes and rivers were protected, for the most part, by high,

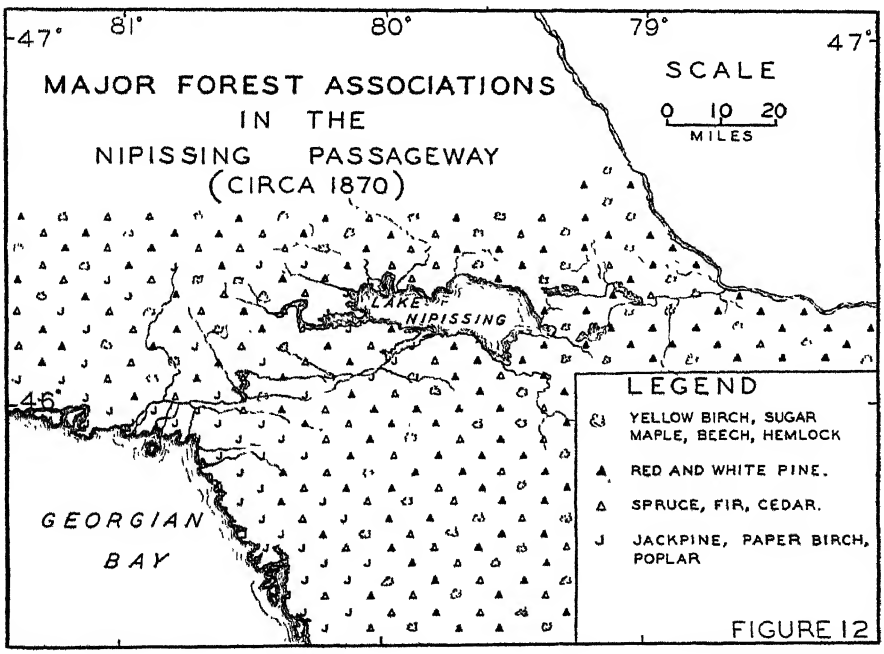

FIGURE 12

forested banks, from the strong winds which frequently made the open waters of Lake Ontario unnavigable for canoes.

Forts were erected at strategic points along the routes of the fur traders to secure the fur-laden canoes against the attacks of hostile Indians. Two of the less important forts are believed to have been built in the Nipissing Area,--on the main portage of La Vase Creek, and at the mouth of the Mattawa River. They were not maintained, however, after the fall of New France in 1763.[1]

Missions established by the French in the Nipissing Area also failed to endure. The Recollets began the mission of Saint Esprit among the Nipissing Indians in 1624. It was abandoned in 1629 when the members of this order were recalled from New France.[2] The Jesuits began a mission to the same tribe in 1640 and it was continued intermittently for nine years. No enduring settlement resulted, however, from the efforts of either group of missionaries.

The forts and missions established by the French during more than a century and a half of travel through the Nipissing Passageway had failed to inaugurate the colonization of the area, and at the end of the French regime in 1763, settlement had not yet begun.

For several years after 1763 only a few canoes passed along the Nipissing Passageway. Scotch and English merchants who had come to Montreal after the British conquest of Canada were at first unwilling to risk their fortunes in trade with Indians who had lately been allies of the French. By 1771, however, the first of the British traders had begun to send canoes up the Ottawa and through the Nipissing Passageway to the fur regions of the west.[3]

Montreal remained the center of the fur trade in Canada, from which the British rapidly extended their commerce over the routes previously established by the French. Many British traders, as competition among them became keener, found the costs of manning and outfitting canoes for long voyages into the interior, prohibitively high. A number of them, to avoid financial ruin, merged into partnerships, the most important of which was the Northwest Company, founded in 1783. This company became successful, not only throughout the former regions of French exploitation, but beyond them as well, extending a fur trade empire westward to the Pacific coast.

The financial headquarters of the Northwest Company was estab-

[1]Voorhis, E., *Historical Forts and Trading Posts of the French Regime*, Ottawa, 1930, pp. 110 and 128.

[2]*Jesuit Relations*, Vol. I, Introduction, and Vol. LXXI, p. 126. The Recollets came to New France in 1615 at the request of Champlain. They were forced to leave in 1629 when the French colonies were surrendered to the English for three years.

[3]Voorhis, op. cit., p. 18.

lished at Montreal, while the main fur depot was shifted to Grand Portage on Lake Superior, and later to Fort William, at the mouth of the Kaministiquia River. Despite these changes, the Ottawa-Nipissing canoe route continued to be the most important avenue in the fur trade from Montreal.

The company introduced more intensive methods of fur-hunting, and built posts in areas once considered unimportant, wherever it was thought they would increase the harvest of furs. British forts were established in the Nipissing Area for the first time under this policy, at the mouth of the Mattawa, and along the Vase and Sturgeon Rivers (Fig. 1).

Mattawa House was founded at the confluence of the Mattawa and Ottawa Rivers, on a low point of land projecting between the two convergent streams (Fig. 2). It was begun around 1784 as a branch of the Temiskaming post 100 miles farther up the Ottawa on Lake Temiskaming, to supply local hunters and trappers and also to serve as a stopover on the routes through the Nipissing Passageway.

The narrow alluvial triangle where the log buildings were erected extends from the base of a range of wooded hills north of the Mattawa. The edge of a slightly elevated shelf of land, lying athwart the peninsula, afforded a favorable site for the trading post, where it was beyond the reach of high water in the spring. On the opposite bank of the Mattawa was a camping ground used by travellers who stopped to repair their fragile canoes, to trade at the post, or to camp overnight. The level terrace, on which the Indians and coureur-de-bois encamped, was crossed by a well-worn portage trail over which canoes and baggage were carried between the Ottawa and the Mattawa to circumvent the rapids at the juncture of the two streams.

The Northwest Company's Sturgeon River House was built about 1880 on the right bank of the Sturgeon River about two miles before it emerges from the north shore of Lake Nipissing (Figs. 1 and 10). The post was established at a point where the river ceases to meander across a low flood plain, and pursues a nearly straight course to the lake. Here the slow-moving stream was sheltered from strong winds which swept across the alluvial plain, by tall ash and maple trees fringing its low banks, thus affording protection to the fur-laden canoes which could glide safely along the calm surface to a landing within a few yards of the log trading post.

Although this post was about 20 miles north of the main line of travel between Mattawa and Georgian Bay (Fig. 1), it served as an important depot for furs gathered in the vicinity of Lake Nipissing and from the forested regions extending more than one hundred miles toward the north.

It will be recalled that the marshy waters of La Vase Creek (p. 11) provided the most convenient route for canoe travel between Trout Lake and Lake Nipissing. At the mouth of La Vase Creek, on its left bank, stood a solitary structure, called by the Northwest Company, Fort La Ronde. James J. Bigsby, stopping here in 1819, reports it "a decent, ordinary house, not stockaded, with a potato ground close to it, among marshes and gneiss mounds.[1]

Fort La Ronde was never an important trading center, although its location on Lake Nipissing at the mouth of the Vase, suggests that it functioned as a supply and repair station on the main canoe route between Mattawa and Georgian Bay. The site was later abandoned in favor of a small island off the north shore of the lake near the mouth of the Sturgeon River, its name having been changed to Nipissing House, and later, it was moved again to Dukis' Point, where it was abandoned altogether by 1856.[2]

Although the posts endured, the Northwest Company which founded them was destined to pass out of existence. Facing bankruptcy from costly competition with the Hudson's Bay Company, the Northwesters merged with their rivals in 1821. The Hudson's Bay Company acquired by the transaction all the material holdings of their former competitor, including forts and trading posts.

From the time of its founding in 1670 the Hudson's Bay Company had developed a monopoly of the fur trade over most of the lands draining into Hudson's Bay. The principal tributaries of Hudson's Bay had carried an increasing number of heavily laden York boats to the company's posts along the shores of the bay for many years. Control of the vast empire was centered at York Factory on its west coast.

After the union of the two companies, Montreal's importance as a fur trade center declined rapidly, for most of the furs from western Canada were then sent to the posts on the shores of Hudson's Bay. York boats, carrying furs down the Churchill, Nelson, Severn, Albany, and Moose Rivers to Hudson's Bay had replaced the birch canoes of the Northwest Company as the principal means of inland travel in the fur trade. By 1825 Montreal had completely lost its preeminence as a fur trade center to York Factory.

In the Nipissing Passageway, Sturgeon River House and the post at Mattawa were kept in operation by the Hudson's Bay Company. The valley of the Ottawa, however, no longer echoed to the shouting and singing of the *voyageurs*, and the lakes and rivers of the Nipissing Passageway were all but deserted. More than two hundred years had

[1]Bigsby, J. J., *The Shoe and Canoe*, London, 1850, 2 V., Vol. I, p. 165.

[2]Voorhis, E., op. cit., p. 128; Logan, W. E., *Canadian Geological Survey, Report*, 1853-56; Plans, No. 8; Author's Field Notes.

passed since Champlain and LeCaron first crossed Lake Nipissing. Since that time, many hundreds of French and British traders had travelled through the Nipissing Passageway. When the fur trade period ended in 1825, the settlement of the area had begun, with the two small trading posts at Mattawa and Sturgeon Falls.

Lumbering—1825 to 1881

Although the first population centers had been established by 1825, the earliest enduring agricultural settlements were brought to the Nipissing Passageway by the lumbering industry during the period that followed. Logging operations had begun far down the Ottawa in 1806, after which the search for timber was rapidly extended westward up the valley into the forested regions of virgin pine, birch and maple. By 1835 the Ottawa timber trade had reached the mouth of the Mattawa, and about twenty years later the first lumber camp appeared in the Nipissing Passageway.

Colonization from the lower Ottawa and St. Lawrence valleys followed slowly the advance of the lumbermen. Nevertheless, not long after logging operations were begun in the Nipissing Area, a few settlers arrived to take up homesteads. The assurance of a market for oats, hay, and potatoes at the lumber camps induced a number of colonists

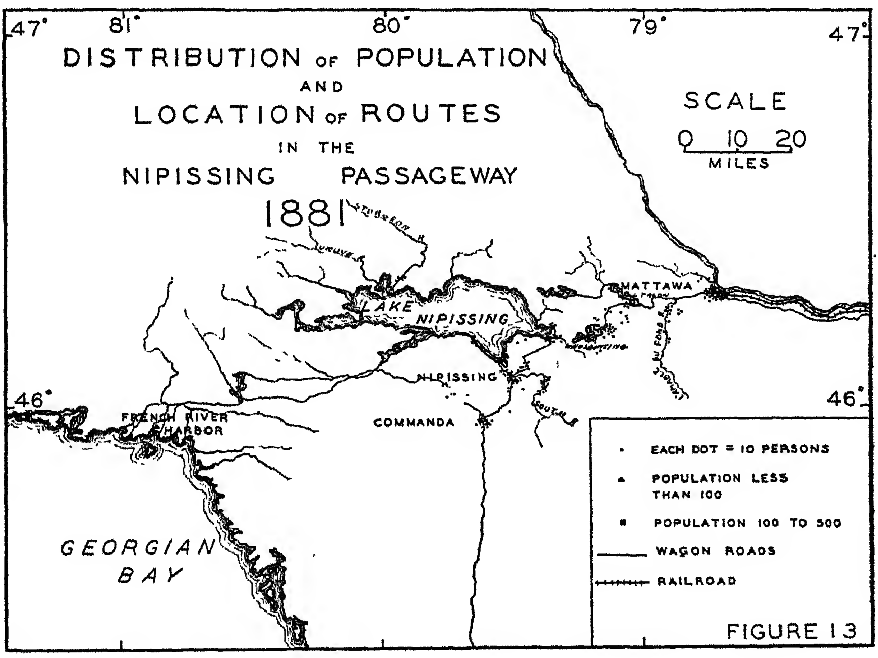

FIGURE 13

to begin farming around Mattawa, Lake Nosbonsing, Lake Talon, and South River (Fig. 13), before 1870. To encourage the settlement of undeveloped lands in Northern Ontario, the provincial government built two colonization roads into the area in this period, one of which was constructed along the southern bank of the Ottawa, and was completed to the village of Mattawa in 1874. The other led north from Rosseau Lake to the village of Nipissing on the South River, and was completed in 1875. By the end of the period in 1881, the lumbering industry was progressing rapidly, and the expansion of agricultural settlement in the Nipissing Passageway had begun.

The Ottawa River, largest tributary of the St. Lawrence, drains a forested area of more than 56,000 square miles, most of which lies in the Laurentian Upland of Ontario and Quebec. In the first half of the 19th century the basin of the Ottawa and its adjoining lands became the most important region of forest exploitation in eastern Canada, and the Ottawa River was for many years a busy thoroughfare in the transportation of timber.

In 1800 the trees which dominated the virgin forests of this vast territory were pine, hemlock, birch and maple. Of these, the timber merchants preferred the pines for their great height and girth, and the qualities of their wood. When lumbering was begun on the Ottawa in 1806, it was thought that the supply of red and white pine was inexhaustible, and only the largest and best trees were taken. At this time, and for many years to follow, the building needs of Great Britain's industries and expanding navy provided a ready market for Canada's timber. In the naval building program especially, long straight timbers were required, light, yet strong and durable enough for masts, yardarms, and deck planking. Lumber from the red and white pines admirably satisfied these requirements.

The numerous streams forming a network of drainage into the Ottawa became an important factor in the development of lumbering in the Ottawa Valley. Because the pine logs would remain afloat for long periods, they could be driven down the smaller tributaries to the Ottawa, and then be transported in rafts to the St. Lawrence, and on to the main lumber port of Quebec. It was natural therefore, that logging operations became inseparably associated with the streams and lakes draining into the Ottawa River. It was thus, with the passage of time, that the Mattawa played an increasingly important role in the timber trade of the Ottawa, for the forested hills through which it flowed, as well as those bordering Lake Nipissing and the French River, were found to bear many dense stands of red and white pines, Fig. 12.

The first logging camp or *chantier* appeared about 1855 in the Nipissing Passageway. It was erected on the right bank of the Mattawa

a short distance above Paresseux Falls. The only settlement in the area at that time, besides the Hudson's Bay posts at Mattawa and Sturgeon Falls, was a single log cabin at the mouth of the Mattawa on the bank opposite the trading post. After 1855 the number of timber operators in the Nipissing Area increased each year. Around 1860 logging camps appeared on Antoine Creek, L'Amable du Fond River, Lake Nosbonsing, and Talon Lake. Still the area of settlement had expanded only slightly,—chiefly along the alluvial terraces near the mouth of the Mattawa River, for there was little inducement at that time for the bush workers to remain in the forest wilderness the year 'round. Trees were felled in winter time and rafted down the Ottawa in spring. Thus, every autumn a large number of men arrived at Mattawa, made their way into the forests, worked all winter at the logging camps, and then joined the annual spring drive down the Ottawa.

The village of Mattawa during the lumbering period expanded rapidly along the left bank of the Mattawa River, southward and westward from the trading post site (Fig. 2). An Oblate church and school were erected on the left bank and these became the center of the community. In a few years the log cabins of the tiny village had begun to crowd against the wooded hills which lie close to the north shore of the Mattawa. With the continued growth of the settlement, log cabins and hotels were built on the south bank of the Mattawa, and in 1877 the two parts of the village were connected for the first time by a bridge.[1]

To-day the main administrative, business, and residential sections of Mattawa occupy the south bank of the river. Here are located the town hall, the post office, two Protestant churches, most of the trading establishments, and a large residential area. Across the river, in the older part of town, the Roman Catholic church and school have remained, and many of the log cabins which formed part of the original settlement may still be seen.

In 1864 the township of Mattawan was surveyed, and the surveyor's records suggest the extent of settlement around Mattawa at that time.[2] "There are already at the Fort a large Catholic chapel, two good hotels, a Hudson's Bay Company general store, and on the Antoine, a couple of miles distant, Mr. McConnel's sawmill. The nearest post office at present is the Joachim, to which place there is a weekly mail from Ottawa. . . . There is as yet no grist mill, the high prices for hay and oats leading the few settlers there are to cultivate hardly anything else;

[1]Buies, A., *L'Outaouais Superieur*, Toronto, 1889, p. 109.

[2]Kirkwood, A. and Murphy, J. J., *The Undeveloped Lands in Northern and Western Ontario*, Toronto, 1878, p. 166.

it being more profitable to buy flour for their own use and devote all their land to growing the beforementioned crops." The chapel referred to here was erected in 1864 by the Oblate fathers who had been visiting Mattawa regularly since 1836. The two hotels were newly built at the time of the survey to accommodate some of the woodsmen and their employers during the busy fall and winter seasons of the timber trade The post office at Joachim was situated at Joachim Rapids, some sixty miles down the Ottawa.

The surveyor's account of the leading crops raised in the area, and the high prices paid for them, indicates the close relationship that was developing between colonization and lumbering. Oats, hay, potatoes, and meat were the chief farm products needed at the lumber camps, and it was a difficult and costly matter to transport these bulky commodities from the farms along the lower Ottawa and St. Lawrence.

Efforts were made by the lumber merchants to establish depot farms near their lumber camps, and otherwise to supply the necessary products of the farm to the men and animals in their employ. These efforts were unsuccessful in lowering prices, however, and they continued to bring in supplies from farms far down the Ottawa Valley at high cost. An opportunity was thus created for enterprising colonists to clear land and raise crops to sell at a high profit to the *chantiers*.[1] By the time the township of Mattawan was surveyed in 1861, a few shantymen and a small number of adventurous settlers from southern Ontario and Quebec had begun to take up farm land along the Mattawa River. Most of the new colonists devoted their lands to the raising of crops, for they were unable to take advantage of the good market for meat products, at least before the arrival of railroads, because of the high cost and difficulty of transporting cattle, sheep and hogs to their farms. In later times, however, livestock-raising became the leading occupation of farmers in the Nipissing Area.

The pioneer farmers were able to earn money in winter by working for the timber operators in the bush, and thus by combining a wintertime occupation with summertime farming, they were able to make a satisfactory living on the relatively poor land in the Nipissing Passageway. To this day the majority of farmers in the area work in the bush during the winter months to supplement their incomes.

The westward movement of settlers in the Nipissing Area was seriously handicapped for many years by the lack of roads. In spite

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[1] "The farmer who follows in the wake of the lumberman finds . . . in the wants of the latter, a steady demand for all he produces, at a price not only equal to that procurable in the ordinary marts, but increased by the cost of transport from them to the scene of the lumbering operations." Kirkwood, A. and Murphy, J. J., op. cit. p. 15.

of this drawback, the limits of settlement were pushed farther and farther westward by pioneers who explored the forests for new homesteads by travelling in canoes on the lakes and rivers. In 1865 John Beatty arrived at Mattawa, and following the historic route of the fur traders, proceeded by canoe up the Mattawa to Lake Nipissing, and thence up the South River to the first waterfall. On the right bank of a small creek that enters the South River at this point, he set up a temporary shelter and began clearing the land. In the neighborhood of Beatty's farm a small colony began to develop a few years later, called Nipissing Village (Fig. 13). Thus, by 1865, the settlement of the Nipissing Passageway had extended westward to the land south of Lake Nipissing. Still, during the next ten years, most of the settlers from the Ottawa Valley took up land east of Lake Nipissing and south of the Mattawa River, for this was the chief area of lumbering activity, and settlement remained closely allied with the timber trade.

The first official census giving population figures for the lands in the Nipissing Area in 1871, indicated that there were 400 people living in the area at that time.[1]

That summer a coach service was inaugurated between Mattawa and Deux Rivières. The weekly coach followed the line of the unfinished colonization road which extended westward from Pembroke along the south bank of the Ottawa. The road was completed in 1874 but was used more by lumbermen and the public coaches than by incoming settlers.

A colonization road, extending northward from Rosseau Lake, reached the South River near John Beatty's farm in 1875, giving rise to a new center of population expansion which soon acquired the name of Nipissing Village. The township of Nipissing, in which the village lies, was surveyed in 1874, and at that time its total population was included in nine families who were living along Beatty Creek, which joins the South River four miles from its mouth. Three years later, in 1877, the settlement had expanded noticeably, and included a small sawmill, a grist mill, a post office and public school. Two hotels were built at the village a short time later to accommodate the growing number of colonists from the south. Thus, for a few years, Nipissing Village was a busy terminal on the colonization road, and its population increased to almost 300. Later, when a railroad was built northward from Gravenhurst, it lost its importance and the population declined. Nipissing Village, whose population is now around 200, has never become an important center of settlement chiefly because of the scarcity of arable land around it (See pages 102-103). However, it remained for many years

[1]Canada, Department of Agriculture, *Census of 1870-71*, Ottawa, 1873-78, Vol. I.

an important stepping off point for pioneers who developed the settlements of Powassan, Callander, North Bay, and Sturgeon Falls.

By 1881 branch roads had been extended by the provincial government from Nipissing Village to a small settlement on Southeast Bay (Callander), and eastward toward Powassan. From Commanda, twelve miles south of Nipissing Village, roads were also built toward the east into Himsworth Township, and north-westward toward the village of Restoul.

From 1875 until the end of the lumbering period, colonization of the Nipissing Passageway expanded from the two population centers at Nipissing Village and Mattawa. By 1878, however, lumbermen from the Georgian Bay area had begun to drive timber from Lake Nipissing down the fifty mile course of the French River to Georgian Bay. This was the beginning of a long period of timber drives down the French River, which resulted in the founding of the small lumber fort of French River Harbor around 1880 (Figs. 3 and 13), on the east bank of the main channel, one mile north of Georgian Bay. This was the only settlement, consisting at that time of docks for the steam tugs and a few frame dwellings, established along the French River in the period 1825 to 1881.

During the lumbering period, logging operations almost invariably preceded the settlement of undeveloped areas in the Nipissing Passageway. From Nipissing Village, settlement was encouraged by the construction of colonization roads into the bush, but elsewhere in the area, pioneer travel was undertaken during those years without the advantage of government-built roads. Travellers from Mattawa made their way in boats or canoes along the Mattawa River and its tributaries, or laboriously drove their wagons over the narrow bush trails of the lumbermen. On Crooked Chute Lake, Sharpe's Creek, Lake Nosbonsing, and Lake Talon small settlements were begun by these means, which later formed the nuclei of population centers south of the Mattawa.

Very often, during the last few years of the period, a lone pioneer struck out into the forest before the advance of the lumbermen. Thus in 1880 we find single families living in isolated clearings on the banks of the Pickerel and Restoul Rivers, and near the north shore of Lake Nipissing (Fig. 13), surrounded by forests of virgin pine, birch, and hemlock. The townships of Springer and Caldwell, on the north shore of Lake Nipissing near the Sturgeon River, were occupied by homesteaders at least as early as 1879.

The distribution of population in the Nipissing Passageway, according to the census of 1880-81 is shown on the map (Fig. 13) with modifications and additions based upon surveyors' reports and official government records of that time. The principal elements in the settlement of the area were the two villages of Mattawa and Nipissing Village, and numer-

ous scattered farms and logging camps. In addition, on the southeast bay of Lake Nipissing and at the east end of Lake Nosbonsing, were two small clusters of population which later became respectively the villages of Callander and Bonfield. The tiny lumber port of French River Harbor, surrounded by an expanse of bare, rocky, and uninviting ridges, was destined to be abandoned in later years when lumbering activity on the French River ceased (See page 109).

At the close of the period 1825-1881 the distribution of population in the Nipissing Passageway corresponded closely with the areas of logging operations. This correlation was chiefly due to the mutual economic advantages enjoyed by lumbering and farming on the frontier lands of the area. The successful introduction of agricultural settlement in this period had depended upon the presence of an accessible market for the few crops which could be harvested from the scattered patches of good soil. Hence the increase in settlement in the Nipissing Area, from a few employees of the Hudson's Bay Company in 1825, to a year 'round population of about 2300 in 1881 (Fig. 13) was mainly owing to the development of lumbering in the area.

RAILROADS—1881 to 1891

In the decade between 1881 and 1891 the construction of the Canadian Pacific Railroad through the Nipissing Passageway resulted in a marked increase in the population of the area. By 1883 its rails had passed westward beyond the Nipissing Area, and in 1886 it was joined at La Vase Creek by the Northern and Pacific Junction Railroad, extending northward from Gravenhurst.

Along the new railroads, where stations, water towers, and other facilities were erected, the log houses of the pioneers began to appear, some of which became the centers of towns and villages, while others, in time, disappeared. Subsidiary routes were connected with the railroads, and farms were established around the new communities wherever pockets of arable land could be found. At the close of the period the foundations of the modern road system and the present pattern of settlement had been established. By 1891 the population of the Nipissing Area had increased to nearly 12,000, most of which was distributed along the railway lines and the newly-built wagon roads. In addition, some settlements had begun to expand around farms and logging camps far removed from the main routes of travel (Fig. 14).

Along the southern bank of the Ottawa River, the Canada Central Railroad was extended to the village of Mattawa in 1881. During the next two years this railroad, which was absorbed by the Canadian Pacific in 1881, was continued westward as far as the present city of Sudbury.

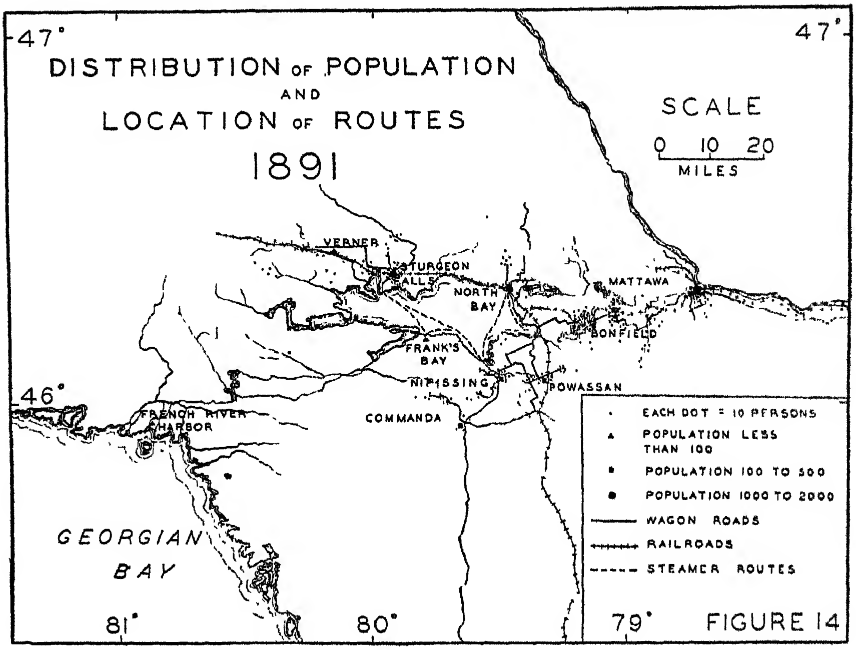

FIGURE 14

The difficulties of building the Canadian Pacific across an uninhabited, uncleared, and irregular terrain were offset somewhat by the presence of an inexhaustible supply of timber, sand, gravel, and boulders for construction materials. The dense forests which yielded red and white pine to the lumbermen, provided the railroad builders with hemlock and jackpine for ties, oak and other hardwoods for bridges. Sand, gravel, and boulders were obtainable from the scattered pockets of glacial till and outwash which are present throughout most of the Nipissing Area.

In the forests through which the railroad was constructed, were occasional large clearings, made by lumbermen and settlers during the previous period of lumbering. The widespread felling of trees and the careless use of fire had led to an appalling spread of forest fires which had laid waste thousands of acres of woodland throughout the Nipissing Area. Coniferous trees, because of their highly inflammable needles and pitch, were especially vulnerable to forest fires. Indeed, surveyors often observed that the charred areas of land were bounded by stands of hardwood trees whose trunks and leaves had resisted burning. The wide expanses of burned-over land were given the name *brûlé* by the French-Canadians who worked at the logging camps, and the word is often heard to-day in the same usage. Everywhere that fire spread through the land, a dense cover of white birch, poplar, and wild cherry sprang up.

When the Canadian Pacific was extended into the Nipissing Passageway, Mattawa was the only village on the line it eventually followed toward the west (Fig. 13). By 1883, when it reached beyond Lake Nipissing, new settlements had appeared along the route, at Crooked Chute Lake, Sharpe's Creek, Lake Nosbonsing, La Vase Creek, Lake Nipissing, Sturgeon River, and Veuve River.

At the eastern outskirts of the present town of Mattawa, the Canadian Pacific curves away from the Ottawa, passing south of the town, along the foot of a rocky, wooded slope (Fig. 2). The high, steep banks of the Mattawa River precluded the establishment of a right-of-way near it, and instead, the most practicable route was discovered to wind circuitously through the valleys of its tributaries (Fig. 14).

West of Mattawa the roadbed pursues a winding course along the lower slopes of the forested hills, skirting the shores of numerous small lakes and swales, and gradually rising in elevation until it crosses L'Amable du Fond River, where it turns sharply southward and passes close to the shore of Crooked Chute Lake, about eleven miles from Mattawa. Where the waters of Smith Lake pour into the Crooked Chute, through a narrow rocky defile, a sawmill was built about 1880, to provide lumber for the settlers in the surrounding area. When the Canadian Pacific was built along the shores of these lakes in 1881-82, the tracks were laid within a hundred yards of the mill, on the opposite bank of the channel. The sawmill supplied lumber for many needs of railroad building, and it soon became the center of a busy construction camp. A station was erected near it, and the small community named Eau Claire, which developed in the vicinity, was thus established.

Colonists who stopped at Eau Claire found the rocky countryside unsuitable for farming, and many of them moved up the fertile valley of L'Amable du Fond to establish their farms. Several years after the period of railroad building ended, the community center of Eau Claire was shifted to a crossroads two miles south of the station, closer to the heart of the agricultural area (Compare the maps, Figs. 14 and 15). Here it has remained until the present day, where a school, general store, and post office are the main elements in the community structure. Near Eau Claire station a cattle-loading ramp has been built, but the sawmill and construction camp were removed long ago.

About six and a half miles beyond Eau Claire, the railroad crosses Sharpe's Creek, having gained an elevation of 227 feet above the station at Mattawa. Between Sharpe's Creek, Blue Seal Creek, and the Kaibuskong River is a broken expanse of fertile clay-loam soil, indistinctly merging with the sandy soils on the rising slopes of the Nipissing Depression (Fig. 1), to the south. Pioneers had taken up land near Sharpe's Creek as early as 1875, and a Canadian Pacific station was

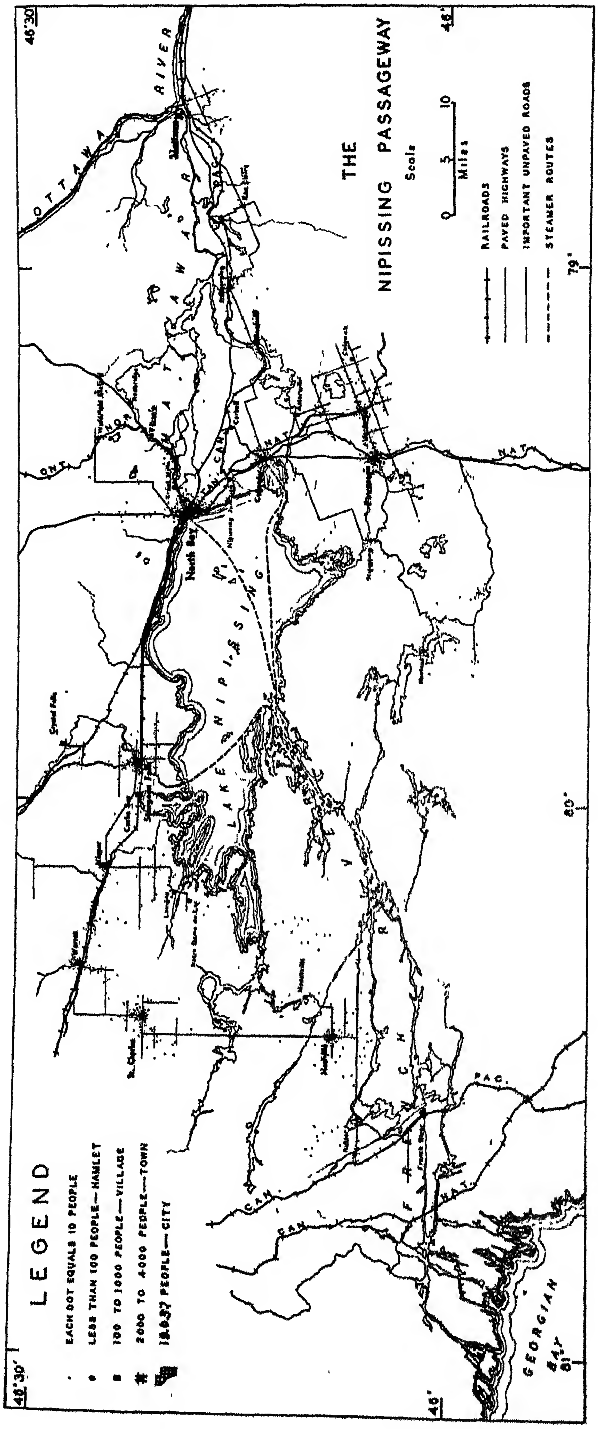

FIG. 15. Distribution of population and positions of routes—1940.

erected near the promising settlement after trains began running regularly along the line in 1882. Later the station was moved to its present site at Rutherglen (Fig. 15), three hundred yards east of Sharpe's Creek, where a cattle-loading platform, general store, post office, and two churches form the nucleus of the modern village.

Several miles southwest of Rutherglen, at the foot of Lake Nosbonsing, the David Moore Lumber Company had erected a camp in 1861, from which they conducted logging operations on the shores of the lake. Settlers established farms on the fertile patches of land near the site of Moore's camp, and by 1875 a small community named Callander had developed around the foot of the lake. The name of the settlement was later changed to Bonfield (Fig. 15), distinguishing it from the colony on Southeast Bay (Lake Nipissing), which had also acquired the name Callander. The latter place is the modern village of Callander made famous in recent years by the Dionne family.

In 1884 the J. R. Booth Lumber Company built a railroad beween the mouth of the Wistawasing River and the head of Lake Nosbonsing. Logs were hauled out of Lake Nipissing by means of a decking ladder, loaded on flatcars and transported by rail for six miles up the valley of the Wistawasing to Lake Nosbonsing. Here they were rolled into the water and towed by steamer across the lake to the Kaibuskong River, where they were driven down the rapids to the Mattawa.

Bonfield became an important trading center for the lumbermen because of its position beside the Canadian Pacific Railway and at the head of the Kaibuskong River. Years later, when the lumbering industry declined around Lake Nosbonsing, the village lost its importance and became the quiet center of a farming district which it has remained to the present day (Fig. 16).

The Canadian Pacific crosses the Kaibuskong at Bonfield, following the irregular shoreline of Lake Nosbonsing westward for about four miles, after which, turning northward, it eventually gains the banks of La Vase Creek. Passing along the north bank of this stream, it gradually turns northwestward to touch the shore of Lake Nipissing near the outlet of Chippewa Creek. The railroad had reached this point n 1882.

Settlers who travelled the Canadian Pacific during the next few years found the countryside it traversed west of Lake Nosbonsing unattractive for farming. In time, however, a small amount of fertile land was discovered between the line of the railroad, Lake Nosbonsing, and Southeast Bay, and by 1891 a number of farms had been established in that section.

To serve the needs of the scattered colony, stations were built along the Canadian Pacific at two points between Bonfield and Lake Nipissing,

where hotels, stores, and post offices soon appeared, and for a brief time were the centers of colonization. Three miles west of Bonfield, where the railroad turns away from the lake, a tiny hamlet called Nosbonsing was founded which became the center of an expanding rural community north and west of it. From the lakeshore a few yards below the station colonists were able to reach all points on the shores of Lake Nosbonsing by boat, before roads were constructed to permit travel into the area by land. The settlement declined when roads were built from Bonfield and the colonization centers near Lake Nipissing. Hotels and stores were ultimately abandoned, and the post office was discontinued in 1937, when only a few families remained near the village site.

FIG. 16. Village of Bonfield. View eastward across the head of the Kaibuskong River, toward the center of town. Past this point the Kaibuskong once bore timbers from Lake Nosbonsing (to right of photo) eight miles downstream to the Mattawa.

Nine and one-half miles beyond the village of Nosbonsing, on the banks of La Vase Creek, Thornecliff station, established as a supply depot and construction camp for the advancing railroad, experienced a like development and eventual decline. To-day, the site of this once busy frontier village is occupied by a few farms and the decaying remains of habitations that once housed its pioneer colony. Throughout the Nipissing Area not a few of the original settlements have enjoyed a similar brief period of importance, only to be abandoned later when their populations were attracted to more favorable situations.

In 1882, when the first Canadian Pacific engine crept along the newly-laid tracks across Chippewa Creek, a solitary cabin occupied the

RCAF Photograph

FIG. 17. Sturgeon Falls. The cascade after which the town is named is in the center of the picture (The Canadian Pacific Railroad crosses the river at the foot of the falls). A large pulp mill is on the right bank at center of picture. Above the mill are two rafts of logs. Those on the left are destined for the pulp mill. Those on the right will pass down the flume (center) to the lower Sturgeon (see Figure 10), and thence to Lake Nipissing. North toward top. Scale: about 4 inches to the mile.

site of modern North Bay. The railroad men chose this site as a major divisional point on the transcontinental line to the west, where a round-house, coal depot, repair station, and other facilities were established. The expansion of the city, on the bare rock and thin soils west of Chippewa Creek, is chiefly the result of its increasing importance as a railroad center.

West of North Bay the railroad right-of-way lies along the north shore of Lake Nipissing, a few yards above the water level. Beyond La Ronde Creek the tracks were laid in a straight line due west for twelve miles, upon a road bed built well above the moist alluvial low-lands it traverses (Fig. 14). The railroad rises only a few yards before crossing the Sturgeon River, twenty-four miles west of North Bay, turning slightly to the right as it passes along the head of McLeod Bay.

The Canadian Pacific crosses the Sturgeon River at the foot of a steep cascade, about two miles upstream from the site of the Hudson's Bay trading post (Figs. 10 and 17). By 1880 settlers had begun to build log cabins along the river, near the trading post and around the foot of the falls, where a general store had recently been built. In a few years a town plot was surveyed around the settlement, for its site and situation seemed favorable for the development of industries. The waterfall was a source of power for future sawmills and gristmills, while the intersection of the Canadian Pacific railroad with the water route of the Sturgeon suggested that a transportation center might be developed. By 1891 Sturgeon Falls had, in fact, become an important trade and transportation center for the newly-settled areas along the northern and western shores of Lake Nipissing. It gained further importance during the following period when a large pulp mill was constructed at the falls.

West of the Sturgeon River the Canadian Pacific passes along the head of McLeod Bay, a few miles beyond which it turns northwestward to a bend in the Veuve River, following the north bank of this stream for nearly thirty miles (Fig. 14). The tracks were laid along the Veuve in 1883, on the deep varved clays, glacial till and outwash, which fill the valley.

About one and one-half miles beyond the point where the railroad reaches the Veuve, the present village of Verner was established as a stopping place when the tracks were laid. Nine miles west of Verner, another railroad stop, called Veuve Station, was erected, which later became the village of Warren (Fig. 5). Settlers at Sturgeon Falls and North Bay soon learned about the promising fertility of the fine clay soils in the valley between Verner and Warren, and, although not a single habitation could be found along this section of the Veuve before the railroad was built, farms appeared in ever-increasing numbers after

the tracks had been advanced beyond the two stations. To-day the yellow clay soils of the Veuve Valley, especially between Verner and Warren, have been cleared to the edge of the enclosing rock ridges (Fig. 5), and the villages have become the centers of prosperous agricultural communities (See page 107, and the map, Fig. 18).

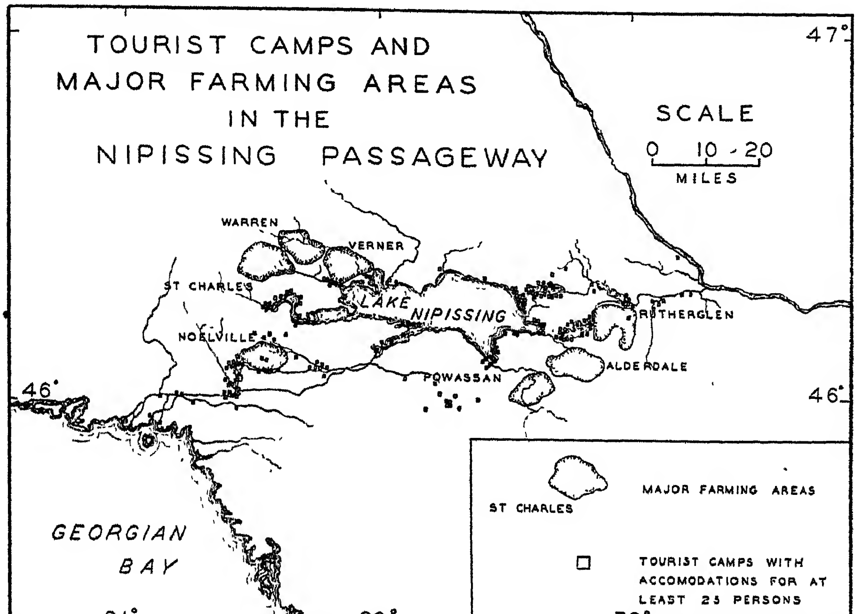

FIGURE 18

By the end of the railroad building period in 1891, a noticeable expansion of agricultural settlement had been started from the population centers established along the route of the Canadian Pacific Railroad.

The influence of the Canadian Pacific on colonization in the Nipissing Area, was supplemented by three additional route systems which were joined with it during the period of railroad building. The first of these was a system of wagon roads branching from the two main routes which were terminated at Mattawa and Nipissing Village during the lumbering period. Colonization roads were built by the Ontario government as a part of a colonization and settlement program instituted by the Dominion in 1868, a year after Confederation.

After the Canadian Pacific had been advanced through the Nipissing Passageway beyond the village of Warren, a system of wagon roads was gradually extended from the main settlements all along the route. By 1891 the modern road pattern had begun to take form.

The second route system which became associated with the Canadian Pacific line was created before 1880 when small sailing vessels carried settlers from the outlet of the South River across Lake Nipissing to its northern shores. In 1881 the first steamboat was launched on Lake Nipissing,[1] marking the beginning of a steamer service that has continued to the present day. By 1883 a steamboat was plying regularly between Nipissing Village, Sturgeon Falls, North Bay and Callander (Fig. 14).

As the settlements around Lake Nipissing increased, many of the colonists set out along its shores in sailing craft, rowboats, and canoes to search for new farmlands. In 1886, an adventurous pioneer named Monet, left Sturgeon Falls with a companion in a small boat to explore the western arm of Lake Nipissing. Passing along the southern bank of West Bay, they entered the mouth of the Amateewakea River, gliding slowly among its many islands, until they came to a low shelf of sloping rock, where they landed their boat to continue their explorations on foot. Travelling southward over rock ridges and low swales, through untouched forests of pine, birch, spruce, fir and cedar, they came at last to a high hill separating the drainage of the Amateewakea from that of the Wolseley River. On the summit of the hill, overlooking the valley of the Wolseley, the presence of large pine, maple, oak, and birch trees, on a deep deposit of yellow clay-loam soil, induced them to establish their farm. Near their pioneer farmstead, the village of Monetville later appeared, and in this way the settlement of the area southwest of Lake Nipissing was begun.

While the beginnings of agricultural colonization were being made along the western bays of Lake Nipissing, logging activities were expanding along the southern shores of the lake toward the French River. By 1885 a lumbering camp was established at Frank's Bay, one mile east of the French River. In the following year the small village which had grown around the camp, was connected by regular steamer service with Callander and Sturgeon Falls. Unlike the settlement at Monetville, from which an agricultural population expanded over areas of arable land around it, the village of Frank's Bay failed to become a center of population expansion. Twenty years after it came into existence, the sawmill was moved to Callander, and the village was soon deserted. All that remains of it to-day are the weed-covered foundations of its docks and buildings, near which summer cottages have been built.

West of Frank's Bay, along the French River, similar small lumbering villages appeared, at Hardy Bay, Chaudière Falls, and French River Harbor. Agricultural settlement failed to develop around all of these

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[1]Ontario. *Sessional Papers*, 1884, No. 4, Commissioner of Crown Lands Report for 1883, Appendix No. 29, p. 42.

lumbering centers as well, and the reason for this is clearly expressed in the nature of the surrounding land. The land surface extending westward from Nipissing Village and Commanda to the shores of Georgian Bay, consists of an endless series of rock ridges and knobs, and low swales. It is a region drained by many interconnected lakes, streams, and marshes, and having only few patches of arable land suitable for farming (see map of modern farming areas, Fig. 18).

The third ancillary route system, in addition to wagon roads and steamer routes, was the Northern and Pacific Junction Railroad (later a part of the Canadian National Railroad) begun in 1884 at Gravenhurst, 100 miles south of Lake Nipissing, (Fig. 14). The tracks were laid northward across the uneven, forested surface of the Laurentian Plateau, rising slowly to an elevation of nearly 1200 feet above sea level, before descending gradually, through a portion of the Hill-Valley physiographic province (Fig. 4) toward Lake Nipissing.

A few miles south of Genesee Creek, a tributary of the South River, the railroad enters a broken expanse of land in which are many shallow, loam-filled valleys, bordered by low, rounded hills of bed rock (Fig. 8). On the south side of Genesee Creek a railroad station was built when the roadbed was laid, and the settlers soon erected pine cabins along the banks of the nearby stream. About two miles west of the station was the settlement of Powassan, founded in 1877 by pioneers from the swelling populations of Nipissing Village and Commanda (Fig. 14). The colonists were attracted to this site by the presence of a waterfall large enough to drive the wheels of the mills they planned to construct. By 1880 a store, post office and blacksmith shop had been added to the settlement, and in later years a power plant was erected at the falls.

After the Northern and Pacific Junction Railroad was completed, the post office, stores, and other establishments were moved to the vicinity of the railroad station, and the original colony on South River declined. Thus it was the railroad that determined the present location of the town of Powassan. To-day the thriving town of Powassan is the trading center of a large farming area (Fig. 18), extending southwestward up to the South River Valley, and eastward over the lands drained by the Wistawasing River and its tributaries.

Northward from Powassan, the Northern and Pacific Junction Railroad was advanced toward North Bay, reaching the settlements of Callander (Fig. 19), and Nipissing Junction by 1886. Owing to the scarcity of good soils around Callander, the village was never developed as an important agricultural center. During the railroad period, however, it became important as a depot for the shipment of supplies and construction materials by steamer across Lake Nipissing to the villages of Nipissing and Frank's Bay. It was not until several large lumber

RCAF Photograph

FIG. 19. Village of Callander. Line of the Northern and Pacific Junction Railroad passes close to the waterfront (lower right to upper left). Lumber yards and log booms of modern Callander's large sawmill appear at left center. Pier for steamers plying across Lake Nipissing in lower center. Center of village inland from the pier. North toward top. Scale: about 4 inches to the mile.

mills (Fig. 19), were built at Callander during the period of Settlement Expansion (see pages 108-109), that it became a busy and prosperous community.

The city of North Bay, where the terminal of the new railroad was established, experienced an appreciable increase in its population after the connection of the Northern and Pacific Junction Railroad with the Canadian Pacific in 1886. It had become a town of about 1850 people by 1891, and was destined to develop into the most important railroad center in northern Ontario during the following period, while it soon became the largest town in the Nipissing Area.

In the period of railroad building, 1881 to 1891, the main elements of present settlement in the Nipissing Passageway were established. By 1891 the population of the entire area had increased to five times what it had been a decade earlier. It has since expanded, from the centers existing in 1891, along lines of travel based upon the route systems laid out during the period.

SETTLEMENT EXPANSION—1891 TO 1949

By the end of the Railroad period in 1891, a growing demand for farm products at the lumbering villages and stopping-places along the railroads, had induced many colonists to begin cultivating scattered areas of fertile soils near the new settlements. During the period of Settlement Expansion that followed, the production of pulpwood and what is popularly called the tourist trade, became equally important in the economy of the Nipissing Area.

The distribution of population, and the location of the main roads and railroads for 1949 are shown on the map, Fig. 15. It is important to note that since 1891, a number of settlements, begun during the lumbering and railroad periods, have failed to survive. For example, French River Harbor, Frank's Bay, and Thornecliff were entirely depopulated many years ago.

Besides the major elements of land use,—farming, lumbering, pulpwood production, and the tourist trade,—the expansion of settlement has been connected with the railroad industry, which is centered at North Bay. The influence of these five leading factors provides a basis for the following discussion.

Since 1891 the number of farms has been increasing on the small patches of arable land in the Nipissing Area. As the land in farms spread farther from the population centers into the forests along the railroads, the Ontario government continued building wagon roads in

the newly-cleared territories. Road building was a part of the provincial colonization program, which included the offer of free or low cost land to settlers in northern Ontario. The program had been started when the Dominion government passed the Free Grant and Homestead Act of 1868.[1]

Encouraged by the offer of free or low cost land, and by the fact that the Canadian Pacific Railroad, in cooperation with the government, agreed to transport colonists to the frontier at reduced fares, settlers began taking up land in the Nipissing Area wherever a few acres of tillable soil could be found. In many cases, after the land had been cleared for plowing, it was discovered that the soils were too sandy, too poorly drained, or too stony to produce good crops. Such lands were soon abandoned and their owners moved to more promising areas, or sought employment in the towns and villages.

FIG. 20. This is the dwelling of an isolated farm on the south bank of the French River, about ten miles upstream from Georgian Bay. The land is used almost entirely for subsistence purposes. It is the only farm along the French River west of the Canadian Pacific Railroad (see Figure 15).

Not many years of pioneering had passed during the period of Settlement Expansion, before it was recognized that there were relatively few, scattered sections of fertile land in the area. These are the lands where the population has remained comparatively stable for the past twenty years. They have become the foundations of enduring settlements in the Nipissing Passageway.

[1]Ontario. *Sessional Papers*, 1869, No. 22, Toronto, 1870, p. 2.

By 1930, after many years of experimenting with the possibilities of the land, the present pattern of farming areas in the Nipissing Passageway had been formed (Fig. 18). In each major area of good farmland a small village has become the community center, where a post office, church, general store, gasoline station and tavern are the principal components. The fertile areas are known throughout the Nipissing Passageway by the name of their community centers: Rutherglen, Alderdale, Powassan, Verner, Warren, St. Charles, and Noelville.

Farms on the areas of good land (Fig. 18) average between two and three hundred acres, and yield about fifty bushels of oats, and between two and three tons of timothy hay or red clover per acre. They are further distinguished by their well-kept buildings, and herds of cattle numbering about twenty head per farm (Fig. 6). Farms on the poorer lands average between one and two hundred acres, and the yield of oats is only about thirty bushels per acre, and about one and one-half tons of hay. Furthermore, while only about sixty per cent of the land on the better farms can be classed as arable, on the poorer lands the percentage is much less (Figs. 9 and 20).

Owing to the rocky, broken nature of the land, the scarcity of fertile soil, and the shortness of the growing season, farmers in the Nipissing Area have found that the rearing of dairy cattle is the most profitable use of the land. The main source of income is the sale of milk, cream and butter to local markets, and of cheese to the cities of southern Ontario and Quebec. The manufacture of cheese is a small industry which has grown up in the lands west of Lake Nipissing, where six small cheese factories have been established near St. Charles, Noelville, and LaVigne, each of which is operated by one man, with the part-time help of his family (Fig. 21).

Timothy hay, red clover, oats and barley, which grow well throughout the area, provide food for the cattle, and are often raised as cash crops on the larger, and more productive farms. Moreover, the widespread areas unfit for cultivation have been found useful as pasture for cattle, sheep, hogs, and horses. Sheep and hogs are kept almost entirely for local use however, although a sheep and lamb cooperative organization was created at Rutherglen in 1946 to encourage commercial sheep-rearing. In addition, a few farmers, occupying three or four hundred acres of good soil and grazing land, maintain small herds of beef cattle.

The soils of the Nipissing Area are slightly to moderately acidic, and consequently require the application of chemical fertilizers to attain more than a low degree of productivity. The crystalline bed rock of the Nipissing Area is almost entirely without lime, although a few deposits of marl have been found, and beds of crystalline limestone have been reported on the South River, McDonald's Island in Lake Nipissing, and

near Talon Chute on the Mattawa. Only farmers in the regions of good land, as in the vicinity of Alderdale, Verner, and Warren, can afford to pay for commercial fertilizer, as a general rule, and therefore most of the land is farmed without it. It has been found, however, that the acid soils in the Nipissing Area can produce good crops of potatoes, free from scab and other blights, and hence these, and other root crops are grown successfully. A few farmers with the specialized equipment necessary for commercial potato production, and large families to assist in the harvest, have begun to raise potatoes as a major cash crop, usually on the sandy soils along the periphery of an expanse of good farmland.

FIG. 21. A cheese factory at St. Charles. Cheese factories in the Nipissing Area are commonly small, frame buildings like the one shown here, in part of which the proprietor and his family live.

The lumbering industry, which had given the first impetus to widespread colonization in the Nipissing Passageway, has remained an important factor in settlement to the present day. The villages of Cache Bay and Callander became thriving lumbering towns during the period of Settlement Expansion, while Trout Mills and French River Harbor, for a short time, were also centers of lumber production. By 1908 there were three large mills at Cache Bay, two at Callander, one at Trout Mills, and one at French River Harbor.

Sawmills were built at the village of Cache Bay, because of its situation at the head of McLeod Bay, on the main line of the Canadian Pacific Railroad. Timber cut on the west shores of Lake Nipissing and

along the Sturgeon River, was easily rafted on the lake into the protected waters of McLeod Bay (Fig. 10), where it was stored until needed at the mills. The lumber was shipped by rail eastward to the cities of southern Ontario, and westward to the growing settlements in the Prairie Provinces.

As the pine forests around Lake Nipissing became depleted in the two decades after 1908, lumbermen began exploring up the Sturgeon River for new sources of timber. The volume of lumber production gradually decreased, however, and by 1930 only one large mill was able to continue operations at Cache Bay. To-day this mill produces pine lumber, at a greatly diminished rate, from logs cut far up on the Sturgeon River in the vicinity of Lake Timagami.

Similar advantages of site and situation gave rise to the lumber mills at Callander and Trout Mills (Fig. 19). Depletion of the forests led to the decline of lumbering at both of these centers, however, resulting in the abandonment of the industry at Trout Mills in 1935, while only a single sawmill at Callander, now supplied entirely with logs driven down the Sturgeon River from Lake Timagami, is operating at a much reduced rate.

French River Harbor, near Georgian Bay (Fig. 3), was a small timber-shipping port in 1886,[1] having a variable population which was housed in a few frame dwellings during the summer months. By 1908 it had attained the status of a village, with a post office, two churches, two stores, one hotel, a large sawmill, and a population of 350.[2] The site of French River Harbor was unfavorable for settlement, however, for on every side were exposed rock ridges nearly bare of vegetation, sloping gradually beneath the waters of Georgian Bay, while the intervening depressions contained little or no soil. It is not surprising therefore, to learn, that when the pine forests that had supplied this village with timbers were depleted, its population declined rapidly and it soon became deserted. At present only the foundations of the mill, docks, and other structures remain, overgrown with birch, willow, poplar and cherry saplings.

Thus, of the large sawmills that once produced pine lumber in the Nipissing Area, only two remain, one at Cache Bay, and one at Callander (Fig. 22). The former settlements at Frank's Bay and French River Harbor have disappeared (compare the maps, Figs. 14 and 15), while the population centers of Cache Bay, Callander, and Trout Mills have remained. Cache Bay is the only one of these that is still exclusively a lumbering center. Callander is a lumbering village, but it has also

[1] Canada, Department of Mines and Resources, *Great Lakes Pilot, Lake Huron and Georgian Bay*, Ottawa, 1943, p. 235.

[2] Lovell, J., *Gazetteer of Canada*, Montreal, 1908, p. 481.

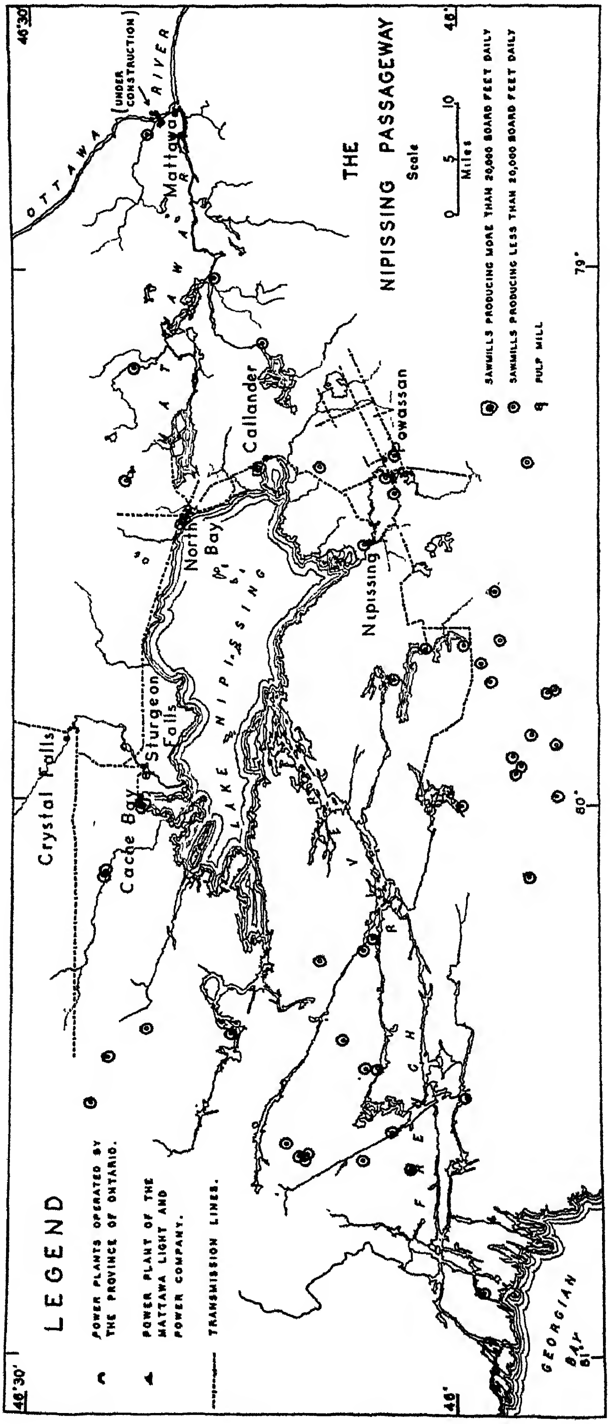

FIG. 22. Distribution of hydro power plants and transmission lines, pulp and saw mills, 1949.

become an important tourist center and a steamer terminal for small vessels travelling across Lake Nipissing to the summer resorts along the upper reaches of the French River. Trout Mills is at present a postal center for the farms, tourist camps, and summer homes along the north shore of Trout Lake, and has the only seaplane anchorage in the Nipissing Area.

In addition to the large mills around which communities have been developed, the small temporary sawmill has played an important part in the use of the land in the Nipissing Passageway. Since the earliest days of colonization, farmers have been able to supplement their incomes by cutting and hauling timber for the small sawmill operators. There are nearly fifty small sawmills in the vicinity of Lake Nipissing today, providing seasonal employment for a rather large number of men (Fig. 22).

Early in the period of Settlement Expansion, a new industry, the production of pulpwood, was introduced in the Nipissing Area when the construction of a pulpmill was begun at Sturgeon Falls in 1898(Fig. 17). The principal raw materials in wood pulp manufacture,—spruce, fir and hemlock trees, remained on the wide areas of cut-over land after lumbermen had removed the more valuable pine. The cutting of trees for the pulpmill became an important winter occupation for farmers and others engaged in seasonal work, as a means of supplementing their incomes. In addition, the new industry resulted in a substantial increase in the population of the town and the adjacent area.

Although pulpwood production, lumbering, and dairy farming have been the chief economic activities during most of the period of Settlement Expansion, still another industry, the tourist trade, has also become important. The Nipissing Area has been a popular vacation land for hunters and sport fishermen since the railroads were built during the 1880's. Small summer hotels and private cottages began to appear along the banks of Lake Nipissing, and the Mattawa and French Rivers, within a few years after the railroads were completed, for many visitors were attracted to these lands by the cool summer weather and an abundant supply of game and fish.[1]

The present importance of the recreation industry, however, has been the result of improved roads, and the widespread use of the automobile. Automobile travel in this section of Ontario became popular after 1934, when the famous Dionne quintuplets were born near Callander. The unusual sight of five, nearly identical infants, has since lured thousands of visitors into the area, and the provincial government, recognizing the value of good highways and tourist accommodations as a means of attracting regular vacationists, has been spending large sums of money

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[1]Canadian Pacific Railroad, *Annotated Timetable*, Montreal, 1890, pp. 16, 17.

annually to resurface and improve the main highways leading into the Nipissing Area. Improved roads lead into remote and unpopulated areas, where the very sparsity of population, and the presence of moose, deer, bear, and wolves, have captured the fancy of summer travellers. The excellence of fishing,—for maskinonge, sturgeon, lake trout, bass and pike,—has become well-known to thousands of Canadian and American tourists.

To-day, many people earn a large part of their incomes in the tourist trade. The number of public camps has been increasing since the end of World War II, and there are now more than 200 tourist establishments in operation along the Mattawa River, Lake Nipissing, and the French River, many of which are shown on the map, Fig. 18.

The center of the recreation industry is at North Bay, a city of more than 18,057,[1] located on the northeast shore of Lake Nipissing. It is situated at the junction of the principal motor highways, railroads and airlines, which cross the Nipissing Passageway (Fig. 15). Although important as the center of the recreation industry, North Bay has become the largest urban community in the Nipissing Area chiefly because of its function as a railroad terminal.

The most important railroad built in the Nipissing Area since 1891, is the Ontario Northland,[2] which was completed between North Bay and New Liskeard on Lake Temiskaming in 1904. It was later extended to Moosonee on James Bay, and became an important link between southern Ontario and the well-known Clay Belt of northern Ontario and Quebec. Although the establishment of its main offices, terminal yards, and repair sheds at North Bay has been an important factor in the growth of the city, the Ontario Northland has exerted little influence on the settlement of lands immediately north of the Nipissing Passageway, for it passes through lands where the soils are too thin, too sandy and too poorly drained for successful farming (see Figs. 15 and 18).

The completion in 1915 of a branch of the Canadian National Railroad from Ottawa, through North Bay to Capreol, north of Sudbury, added still further to the importance of North Bay as a railroad center. This was the last major rail line to be constructed in the Nipissing Passageway.

North Bay, metropolitan center of the Nipissing Area, is a small compact city, built close to the curving northeast shore of Lake Nipissing, in the midst of a vast, sparsely populated section. It has been built upon the rocky undulations of the Low Ridge and Knoll physiographic province (Fig. 4), and about a mile north of the city are the steeply rising slopes of the Hill-Valley province (Fig. 23). The population of

[1]North Bay Board of Trade estimate for 1949.

[2]Formerly the Temiskaming and Northern Ontario Railroad.

RCAF Photograph

FIG. 23. Northwest section of the city of North Bay. Lake Nipissing lower left. Chippewa Creek center right. The scarcity of good farm land around North Bay is indicated by the small number of farms appearing in the picture (see Figure 18). The sharply rising slopes of the Hill-Valley Province appear one mile (about 4 inches) north of the race track (lower right). The curving line of the Canadian National Railroad may be seen crossing the highway leading north to Cochrane. North toward top.

18,000 is housed mainly in modest frame dwellings distributed along streets which are mostly unpaved, and yet are arranged in an orderly, rectangular pattern. A large number of buildings rest upon solid gneiss and granite bed rock, out of which excavations have had to be blasted for basements, sewers, and water mains. Water is supplied from a reservoir fed by Trout Lake, and electricity is furnished by hydroelectric plants at Crystal Falls, Nipissing Village, and Powassan (Fig. 22).

A number of minor industries have been developed at North Bay, taking advantage of its situation as the hub of several important highways and railroads. The following list of some of these enterprises indicates, in part, the varied function performed by the city for the surrounding areas: fur-processing establishments, planing mills, mining equipment factories, a bronze foundry, two publishing houses, a frozen-food plant, radio station, airport, and several large hotels. Branch offices of the provincial government have been established here as well, making it the political capital of Nipissing District.

In addition to the railroads which have influenced the growth of North Bay since 1891, three other lines have been built in the Nipissing Passageway during the period of Settlement Expansion. At Mattawa, the Canadian Pacific constructed a bridge across the Ottawa River in 1895, connecting the main line with a short section of track leading to Lake Temiskaming, along the north shore of the Ottawa (Fig. 2). This railroad, called the Temiskaming Colonization Railroad, had been built in 1887 to carry settlers into northern Ontario and Quebec. After it was joined with the Canadian Pacific system, the village of Mattawa became a transfer point for passengers and freight transported northward by way of this branch. In 1908 the Canadian National[1] and Canadian Pacific Railroads completed lines between Toronto and Sudbury which cross the French River west of Lake Nipissing. They have had little effect upon settlement in the Nipissing Passageway, however, although every year vacationers travel by train to Pickerel and French River Stations, whence they proceed by boat to the tourist camps on the shores and islands of the French River and its tributaries (Fig. 18).

In the Nipissing Area several small industries have been established which manufacture products from locally available raw materials. At Mattawa, for example, there is a veneer plant, producing thin sheets of yellow birch and hemlock for processing into plywood. In 1946 a small spindle factory was begun at Mattawa, where stock for spools and chair rungs is made from white and yellow birch.

During the recent war a mica mine was opened about ten miles west

[1]Then the Canadian Northern Railroad.

of Mattawa, on the north side of the Mattawa River. The high cost and difficulty of extracting suitable crystals of mica from the pegmatite dikes in which they are found, caused the closing of the mine when the war ended. For a brief period, however, it had provided employment for a number of people at North Bay and Bonfield, in the processing of finished mica crystals. This has been the only successful mining development in the Nipissing Area, although other deposits of mica, and small quantities of gold, iron, and uranium-bearing ores have been reported in scattered localities.

Sturgeon Falls is the site of two cooperage factories, where barrel staves, kegs, and broom handles are manufactured from maple, and white and yellow birch trees. An abrasive manufacturing industry has been established here in recent years, where grindstones and other sharpening tools are made from garnetiferous rocks found farther up the Sturgeon River. The commercial fishing industry of Lake Nipissing is centered at Sturgeon Falls where two men make a living fishing for sturgeon, white fish, mullet, and suckers, in the waters between the mouth of the Sturgeon River and the Indian Reserve, five miles toward the east.

On the west side of Sturgeon Falls there is a small mink farm, one of several fur farms in the Nipissing Area. The others are chiefly fox farms, however, at such widely scattered places, as Monetville, North Bay, and Redbridge (see Fig. 15 for locations). Most of the furs produced in the Nipissing Passageway however, are obtained by trappers during the winter months, for the woods and waters of this territory are not yet depleted of the fur-bearing animals which first attracted the French traders in the early years of the 17th century.

Electricity is produced in the region by five hydro-electric power plants, four of which (one at Crystal Falls, two at Powassan, and one at Nipissing Village), are controlled by the Province of Ontario, while the fifth, near Mattawa, is privately owned (Fig. 22). Electric power is furnished mainly to the large population centers of North Bay, Sturgeon Falls, Mattawa, and Powassan, the tourist and lumbering area west of Powassan, and the farming section around Alderdale. In most of the rural areas, however, as suggested on the map, Fig. 22, the farms are lighted only by oil or gas lamps.

Thus, in the Nipissing Area, a number of minor industries, based upon its natural resources, form an essential part of the local economy. With the major industries,—dairy farming, lumbering, pulpwood production, and the tourist trade,—they make up the economic structure upon which the present population of the Nipissing Passageway is founded.

SUMMARY

Over three hundred years ago, when Brulé, LeCaron and Champlain bravely ventured up the Ottawa and through the Nipissing Passageway, they saw only a few bark wigwams along the French River and the shores of Lake Nipissing. Then, for more than two hundred years, explorers, fur traders and missionaries travelled along the Mattawa, Lake Nipissing, and the French. By 1825, however, these waters had ceased to be an important canoe route. At that time only two small Hudson's Bay Company trading posts, and a few Indian wigwams occupied the lands of the area.

The Canadian Shield, traversed by the Nipissing Passageway, resisted the advance of colonization for many years after the decline of the fur trade. At last, however, as the lumbering industry and the building of railroads attracted men from southern Ontario and Quebec into the forested wilderness, settlements began to appear on the banks of its lakes and rivers. By 1891 the beginnings of enduring settlement along the famous canoe route had been made.

To-day the Nipissing Passageway, once inhabited only by a few Indians, has a population of more than 50,000, occupying farms, villages, and towns, and is traversed by well-travelled motor roads and railroads. Its small scattered patches of arable land are mainly devoted to the rearing of dairy cattle, and the raising of hay, oats, and potatoes, while its wooded hills provide timber for lumber and pulp mills. The tourist trade, based upon the lure of cool summer weather, deep forests, and numerous lakes and rivers, is rapidly becoming important, for hunters and fishermen now roam the woods and waters which once were the hunting grounds of Indians and coureur-de-bois.

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TABLE I

AVERAGE MONTHLY TEMPERATURES AT FOUR STATIONS IN THE NIPISSING AREA[1]

	Crystal Falls F°	North Bay F°	Rutherglen F°	Calvin F°
January	8.6	11.5	8.5	7.8
February	7.8	11.7	9.4	9.7
March	21.0	23.7	22.0	10.9
April	35.0	37.9	37.8	39.0
May	49.0	51.0	51.4	52.2
June	58.9	61.6	60.4	61.5
July	63.2	67.0	65.0	65.6
August	60.7	64.8	61.6	61.7
September	53.2	56.2	54.4	55.4
October	41.4	42.6	42.6	42.7
November	28.9	31.1	29.4	29.9
December	15.1	15.7	14.2	13.6

[1]Sources: *Dominion of Canada*, Meteorological Division of Air Services, Monthly Record of Meteorological Observations. Toronto 1875-1944. STUPART, R. F., *The Climate of Northern Ontario*, in Transactions of the Canadian Institute, Vol. IX, 1911, pp. 149-152.

TABLE II

AVERAGE MONTHLY PRECIPITATION AT FOUR STATIONS IN THE NIPISSING AREA[1]

	Crystal Falls Inches	North Bay Inches	Rutherglen Inches	Calvin Inches
January	2.89	2.11	2.08	2.13
February	1.97	1.48	1.92	1.77
March	2.06	1.69	1.88	2.07
April	2.08	1.55	1.66	1.45
May	2.31	2.40	2.79	3.04
June	3.54	3.06	2.87	3.20
July	3.81	2.16	3.43	3.47
August	2.34	2.41	3.01	3.04
September	4.23	3.71	3.55	3.25
October	4.13	3.33	2.90	2.66
November	3.30	2.72	2.45	2.42
December	2.51	1.99	2.06	2.26
YEAR	35.17	28.61	30.60	30.76

[1]Sources: *Dominion of Canada*, Meteorological Division of Air Services, Monthly Record of Meteorological Observations. Toronto, 1875-1944. STUPART, R. F., *The Climate of Northern Ontario*, in Transactions of the Canadian Institute, Vol. IX, 1911, pp. 149-152.

TABLE III

OCCURRENCE OF FIRST AND LAST FROSTS AT THREE STATIONS IN THE NIPISSING AREA, DURING THE TEN-YEAR PERIOD FROM 1930 TO 1939[1]

	Crystal Falls		North Bay		Rutherglen	
	Last	First	Last	First	Last	First
1930	May 30	Sept. 5	May 30	Oct. 4	May 31	Sept. 9
1931	June 1	Sept. 25	May 17	Sept. 25	June 1	Sept. 19
1932	May 28	Sept. 9	May 29	Sept. 30	May 29	Sept. 10
1933	May 14	Sept. 10	May 15	Sept. 10	May 15	Sept. 11
1934	June 7	Aug. 22	May 25	Oct. 1	June 8	Aug. 28
1935	May 31	Aug. 23	May 21	Sept. 23	June 9	Aug. 21
1936	May 30	Aug. 31	May 21	Sept. 25	May 31	Aug. 26
1937	June 30	Aug. 31	May 14	Oct. 8	June 2	Sept. 5
1938	May 24	Sept. 1	May 25	Oct. 2	May 25	Sept. 2
1939	May 21	Sept. 6	May 18	Sept. 24	May 20	Sept. 6
AVERAGE	May 29	Sept. 2	May 22	Sept. 27	May 30	Sept. 5

[1]Dominion of Canada, Meteorological Division of Air Services, *Monthly Record of Meteorological Observations*, Toronto, 1931-1940.

TRANSACTIONS

OF THE

Royal Canadian Institute

No. 59 | October, 1950 | Vol. XXVIII, Part 2

191 COLLEGE STREET
TORONTO 2B, CANADA

A STUDY OF THE BLACK FLY POPULATION OF A STREAM IN ALGONQUIN PARK, ONTARIO*

DOUGLAS M. DAVIES

Department of Parasitology, Ontario Research Foundation, Toronto

INTRODUCTION

Qualitative observations of the life history of various species of black flies have been made for over fifty years but few quantitative studies have been conducted. In this study quantitative data were obtained for several years on the population of black flies in Costello creek, Algonquin Park, by employing a standard method of making daily and hourly collections of emerging black flies. In this way the size and species composition of the population, the sex ratio, the seasonal emergence and the number and length of the generations of each species was determined. Observations of oviposition were made as well. In order to augment the information on a few species, data obtained in a similar manner from other streams in the Park are included.

The classification of the family Simuliidae, proposed by Smart (1945), is used in this paper. Certain more recent synonymies and generic placements established by Stone (1949, 1950) have been recognized as follows: *Cnephia dacotense* (Dyar and Shannon) and *Cnephia subexisum* (Edwards) (both formerly in *Simulium*), *Simulium costatum* Friederichs (=*pugetense* Dyar and Shannon), *Simulium tuberosum* Lundstroem (=*perissum* Dyar and Shannon) and *Simulium decorum* Walker (=*ottawaense* Twinn). In addition *C. lascivum* (Twinn) has been synonymised with *C. dacotense* (D. and S.) by Nicholson (1945).

DESCRIPTION OF COSTELLO CREEK HABITAT

Costello creek is a permanent stream draining Costello lake. The stream moves sluggishly over the first twenty feet which are shallow, weedy and unshaded, after which the gradient steepens forming 400 feet of rapids supporting a large population of black flies. The water level varies from two feet in the spring to less than an inch by the end of the summer, and rises again in the fall (Fig. 6). The stream varies in width from six to twelve feet in the spring but is reduced to a number of small rivulets by later summer (Figs. 1a, b). The bed consists of rocks, ranging in size from one-half foot to four feet in diameter, interspersed with small pebbles which are packed into the bottom with coarse sand. Filamentous algae, eel grass (*Vallisneria americana* Michx.), cattail (*Typha latifolia L.*) and some true grasses grow in the stream, as well as two species of water moss attached to the rocks under the water, of which *Fontinalis*

*This investigation was supported by a grant to the Ontario Research Foundation by the provincial government on the recommendation of the Research Council of Ontario.

dalecarlica Bry. Eur. is the most common. The portion of the stream in which emergence was studied from 1945-1947 is exposed to sunlight for most of the day, whereas the portion farther downstream, in which studies in previous years were made, is more shaded. Further details of the physical, chemical and biological features of Costello creek are presented by Solman (1939).

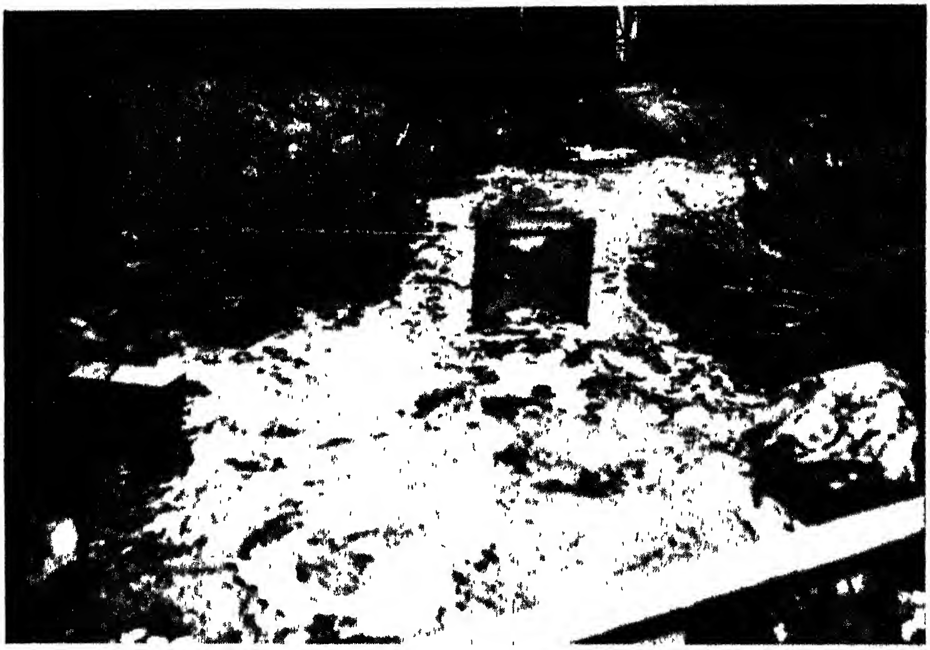

FIG. 1A. Downstream view of Costello creek. High water in May showing emergence cage supported by a rope and the "water" thermograph at left.

METHODS

COLLECTING EMERGING BLACK FLIES

The method, developed by Ide (1940), of sampling the insect population of a stream was used in this study. A cubic yard, screen cage was placed over a square yard of stream bottom and emerging adult insects were collected daily, or hourly, throughout the season. This method gave, with a small or calculable error, a count of the adult black flies which emerged.

The collector entered the side of the cage through a small opening formed by allowing the upper corner of the screening to fold back. A few flies were collected with forceps but most by running the open mouth of a vial, containing 95% ethyl alcohol, along the screening. The daily collections during 1947 were made usually from 3 p.m. to 5 p.m. eastern

standard time rather than at 9 a.m. as was done in previous years. In this way fewer black flies were left in the cage overnight as most of the emergence was completed by mid-afternoon.

In order to reduce the number of flies entering the cage with the collector or escaping when the door was opened, the collector approached the cage rapidly and entered immediately, after tapping the door-side of

Fig. 1b. Downstream view of Costello creek. Low water in August showing in right foreground one of the cattail leaves used in studies of oviposition. Cage in same location as in Fig. 1a.

the cage vigorously. Care was taken not to disturb the stream bed so that black flies would not be dislodged or killed. In most cases a rock which was firmly placed on the bottom and which protruded above the surface, was used as a stepping stone inside the cage. A few adults drifted into the cage in the water, but those drifting out compensated

for this error and it was reduced further by keeping the screening slightly below the water surface.

Another difficulty in sampling the emerging flies was caused by females of biting species forcing themselves through the screen to reach and feed on the collector within. To estimate the extent of this error in 1947 a control cage was set up. The bottom of an ordinary cubic yard cage was covered with screening and placed on the bank near the stream cage and the number of flies coming through the screening during sixty-five minutes of observation from June 17 to July 4 was noted. The approximate number of female black flies entering the cage through the mesh during emergence collections in 1947 was determined by multiplying the average number entering the control cage per minute by the number of minutes the collector was in the emergence cage.

Flies collected within an hour after emergence could be separated from the others, even in alcohol, by their paler, softer integument. Moreover, flies showed little tendency to bite immediately after emergence. Consequently when hourly collections were made, flies which came through the screen could be distinguished from those newly emerged.

ORIGIN OF EMERGENCE COLLECTIONS

Collections of insects taken during the years 1938-1943 from a square yard of Costello creek by Dr. F. P. Ide and students under his direction, were made available for this study. The cages were of 14-16 mesh per inch screening and were placed 250 feet from the lake. Collections from Smith's lake inlet and below Tea lake dam on the Oxtongue river were studied also. In 1944 collections were taken from May 24-30 by Mr. F. Knapp from a cage 75 feet downstream from Costello lake. The stream was sprayed with D.D.T. on July 21 and from July 22-31 Mr. J. Savage made collections from a cage 250 feet from the lake. In 1945 Savage and others began collections from a cage 150 feet from the lake on June 14, too late to cover the period when most of the emergence, especially of the early species, usually occurs.

In 1946 and 1947 emergence collections were made by the author from cages of 20 mesh per inch, copper screen, which were located 150 feet from the lake. Collections from Smith's lake inlet, Smith's creek and Mud creek were also studied. Collections were made in each year on 118±14 days except in the years 1944 and 1945 (Table II). They were begun in May and continued to September in most years.

METHOD OF STUDYING OVIPOSITION

The number of *Simulium venustum* Say and *Simulium vittatum* Zetterstedt ovipositing in the portion of Costello creek under study was gauged in 1946 and until July 10, 1947 by counts of ovipositing females or by estimates based on the number of freshly laid eggs which were

white in contrast to the browner, older eggs. After July 10, a more quantitative method was devised. A fresh, green cattail leaf, one to two feet in length was allowed to trail in the water. This was replaced after each daily oviposition and the old leaf, with attached eggs, preserved in 95% ethyl alcohol. About half the flies, ovipositing in that portion of the stream, were observed to lay eggs on these leaves. The number of eggs on each leaf was calculated by measuring the volume of the eggs by the displacement of alcohol in a 1 c.c. syringe graduated to 0.01 c.c. and by employing the measured relation that the volume of 8640 eggs equalled 0.025 c.c. The number of eggs in fifteen gravid females of *S. venustum* averaged 435. By dividing this average into the calculated number of eggs laid daily, the number of females ovipositing each day was determined.

MEASUREMENT OF PHYSICAL FACTORS

Continuous recordings of the water temperature of Costello creek, and of Smith's creek in 1947, were made by means of a Negretti and Zambra distance recording thermometer (Model T 12284), which can be seen to the left of Fig. 1a. Daily readings of the water level were made throughout the season using a fixed depth stake calibrated in inches. Light intensity was measured with a Weston "Master" exposure meter (Model 715).

RESULTS

SEX RATIO AS INDICATED BY THE EMERGENCE COLLECTIONS

The sex ratio of the species emerging into the cages was calculated from the data given in Tables IV to XIV. In most species the number

TABLE I

THE SEX RATIO OF DIFFERENT SPECIES OF BLACK FLIES FROM COSTELLO CREEK

Species	males	:	females	remarks
P. hirtipes	1	:	1.2	common biter
C. dacotense	3	:	1	does not bite
*C. mutatum**	1	:	200	may bite occasionally
S. aureum	1	:	1.5	not seen biting
S. costatum	1	:	1.5	infrequent biter
S. decorum	1.2	:	1	common biter
S. euryadminiculum	2	:	1	not seen biting
S. tuberosum	1	:	1.3	biter
*S. venustum***	1	:	1.5	common biter
S. vittatum	1	:	1	infrequent biter

*emergence collections from other streams as well as from Costello creek.
**emergence collections of 1946 and 1947 only (see text).

TABLE II

A YEARLY COMPARISON OF THE PERCENTAGE OF BLACK FLIES EMERGING EACH MONTH FROM A SQUARE YARD OF COSTELLO CREEK TOGETHER WITH THE TOTAL NUMBER IN EACH YEAR

Month	1939	1940	1941	1942	1943	1944	1945	1946	1947
May	63.9	36.7	62.2	85.6	82.3	100	—	0	0.01
June	33.7	60.5	16.9	8.0	16.9	—	23.9	40.8	62.4
July	0.7	2.7	12.9	5.9	0.7	—	56.8	59.1	33.8
August	1.0	0.03	6.7	0.4	0.1	—	19.3	0.05	3.8
September	0.7	0.03	1.3	0	0.04	—	—	—	—
Total flies	576	3060	225	1129	7360	89	88	19848	60272
Collection period	May 17-Sept. 11	May 11-Sept. 19	May 8-Sept. 15	May 20-Sept. 11	May 21-Sept. 3	May 24-30 July 22-31	June 14-Aug. 25	May 7-Aug. 25	May 3-Aug. 27

TABLE III

COMPARISON OF THE EMERGENCE OF DIFFERENT SPECIES AT COSTELLO CREEK FROM 1939-1947 EXPRESSED AS A PERCENTAGE OF THE TOTAL EMERGENCE OF BLACK FLIES IN EACH YEAR AND CORRECTED FOR FEMALES OF *S. VENUSTUM* ENTERING CAGE THROUGH THE SCREENING

Species	1939	1940	1941	1942	1943	1944	1945	1946*	1947	Total
P. hirtipes	9.1	16.0	33.4	0.7	87.6	30.6	—	0	0.06	7.4
C. dacotense	3.6	34.9	0.65	69.0	3.1	2.0	—	0.02	6.4	6 4
C. mutatum	1.9	0.21	3.3	1.0	2.3	4.1	—	0.01	0.10	0.27
C. subexcism	0.48	0.04	0	0.10	0.08	0	—	0.04	0.03	0.04
S. aureum	0.24	0.04	0	0.20	0	0	—	0.44	0 82	0.63
S. costatum	0	0.04	0	0.20	0.21	0	—	0.04	0.46	0.32
S. euryadminiculum	77.5	23.2	45 7	0	2.3	0	—	0	0	1.4
S. decorum	1.2	0.10	6.5	1.7	0.03	4.1	28.1	10.3	12.4	10.4
S. tuberosum	0.72	2.8	6.5	10.5	0.52	6.1	7.0	1.0	1.9	1.7
S. venustum	4.8	22.6	3.3	15.6	2.8	44.9	14.0	46 3	71.6	57.7
S. vittatum	0.48	0.07	0.65	1.0	1.1	8.2	50.9	41.8	6.3	13.8
Corrected Total	419	2868	153	1012	6535	49	57	19,824	54,992	85,918
Gross Total	578	3070	225	1129	7360	89	88	19,824	60,272	92,657

*No correction was applied in 1946 as the sex ratio of *S. venustum* was 1 male to 1.5 females.

Note: Two females of *Prosimulium decemarticulatum* Twinn emerged on June 1 and 6, 1943 respectively.

of males almost equalled the number of females, with a slight predominance of the latter (Table I). Females predominated in those species known to feed readily on birds and mammals, except for *S. decorum*.

The most unusual sex ratio was shown by *Cnephia mutatum* (Malloch). No males were collected at Costello creek, which suggests that parthenogenesis may occur in this species. The largest number of males was found in 1946 in the cold, bog-fed stream, Smith's lake inlet, when a ratio of 1 male to 11 females was found. In Smith's creek in 1946, 1 male to 14 females was observed and in 1947, 1 male to 28 females. This suggests that the sexes are more nearly equal in a colder habitat.

The sex ratio of *S. venustum* was determined from the collections of 1946 and 1947 only, as finer mesh cages were used and as a correction for the number of females entering the cage from the outside was applied in 1947.

In 1946 few flies entered the cage from the outside because collections were made between 9 a.m. and 10 a.m. when few flies were active; moreover, there were few active flies in the field that year because of the dry season, the rainfall during the black fly season being half that for the 1947 season.

The sex ratio of *S. venustum* in 1946 was 1 male to 1.5 females, which should be close to the actual ratio for the total population of that species.

In 1947 an average of 1.6 (0.3-4.0) females of *S. venustum* entered the cage through the screening per minute as calculated from observations of the control cage mentioned above. Ninety-three percent of the 104 flies in the control cage were *S. venustum*. Similar results were obtained from the hourly emergence collections of July 8, by separating females of *S. venustum* which had passed through the screening from those which had emerged recently. The number entering the cage varied with the time of day, the greatest number occurring from mid-afternoon to dusk, the maximum being 1.6 females per minute. When the 1947 emergence collections were corrected, a ratio of 1 male to 1.5 females of *S. venustum* was found. Too many variables are involved to arrive readily at an accurate method of correcting each daily collection individually. However, the collections of *S. venustum* for the years 1939-1945 were corrected in Table III to conform to this 1 : 1.5 ratio, because apparently a greater proportion of females passed through the screening from the outside in these years than during 1946-1947 owing to the coarser mesh, which produced a sex ratio abnormally high in females. No correction was made for the other species as few were seen to pass through the screening.

THE TOTAL NUMBER OF BLACK FLIES EMERGING YEARLY AND MONTHLY

A yearly comparison of the number of black flies emerging each month from a square yard of Costello creek is shown in Table II. The larger

number collected during the years 1946 and 1947 than in previous years may have been the result of (1) a more productive site, (2) the use of finer mesh screening in the cages and (3) larger populations in the stream. On July 21, 1944 Costello creek was treated with D.D.T. and no male black flies were collected in the following week or for nearly a year from this date, although no collections were made from July 31, 1944 to June 14, 1945. The emergence was small in 1945 and increased from 1945 to 1947.

The month of greatest emergence before 1944 was May, except for 1940, but in 1945 and 1946 it was July and in 1947 June. The reasons for this change are more apparent when the species composition is considered.

A COMPARISON OF THE NUMBER OF EACH SPECIES EMERGING YEARLY

All species fluctuated greatly in number from year to year (Table III). From 1939 to 1943 inclusive one or other of the early species, *Prosimulium hirtipes* (Fries), *C. dacotense* and *Simulium euryadminiculum* Davies (1949), was the most numerous. In 1945 *S. vittatum* was in greatest numbers. In 1944, 1946 and 1947 *S. venustum* predominated forming 72% of the population in 1947.

The striking differences in the numbers of various species before and after 1944, as compared with the differences between other years, may have been caused by the application of the D.D.T. in July, 1944 although part may have been the result of the change in location of the cage.

After the insecticidal spraying, species with one generation only, such as *P. hirtipes*, *C. dacotense*, *C. mutatum* and *S. euryadminiculum* which were previously often the predominant species, took at least three years to become reestablished. *S. euryadminiculum* did not reappear after the spraying. *P. hirtipes* did not reappear until the third year, whereas a few individuals of the other two species emerged in the second year, but not in numbers until the third year. Large numbers of *P. hirtipes*, however, were found in neighboring streams during 1946 and 1947, and in 1949 and 1950 large numbers of larvae and pupae of *P. hirtipes* were seen again in Costello creek.

Species with more than one generation, *S. venustum*, *S. vittatum* and *S. decorum* reappeared the year following the treatment. The latter two, which previous to 1944 were represented yearly by fewer than twenty and eighty specimens respectively, increased to several thousand each after this year, but in 1947 there were fewer *S. vittatum* again. *S. aureum* Fries and *S. costatum* were scarcely represented before 1944, but increased to several hundred in 1947.

Not only was the size of the emerging population different for most species after 1944, but also the dates of the first emergence of males

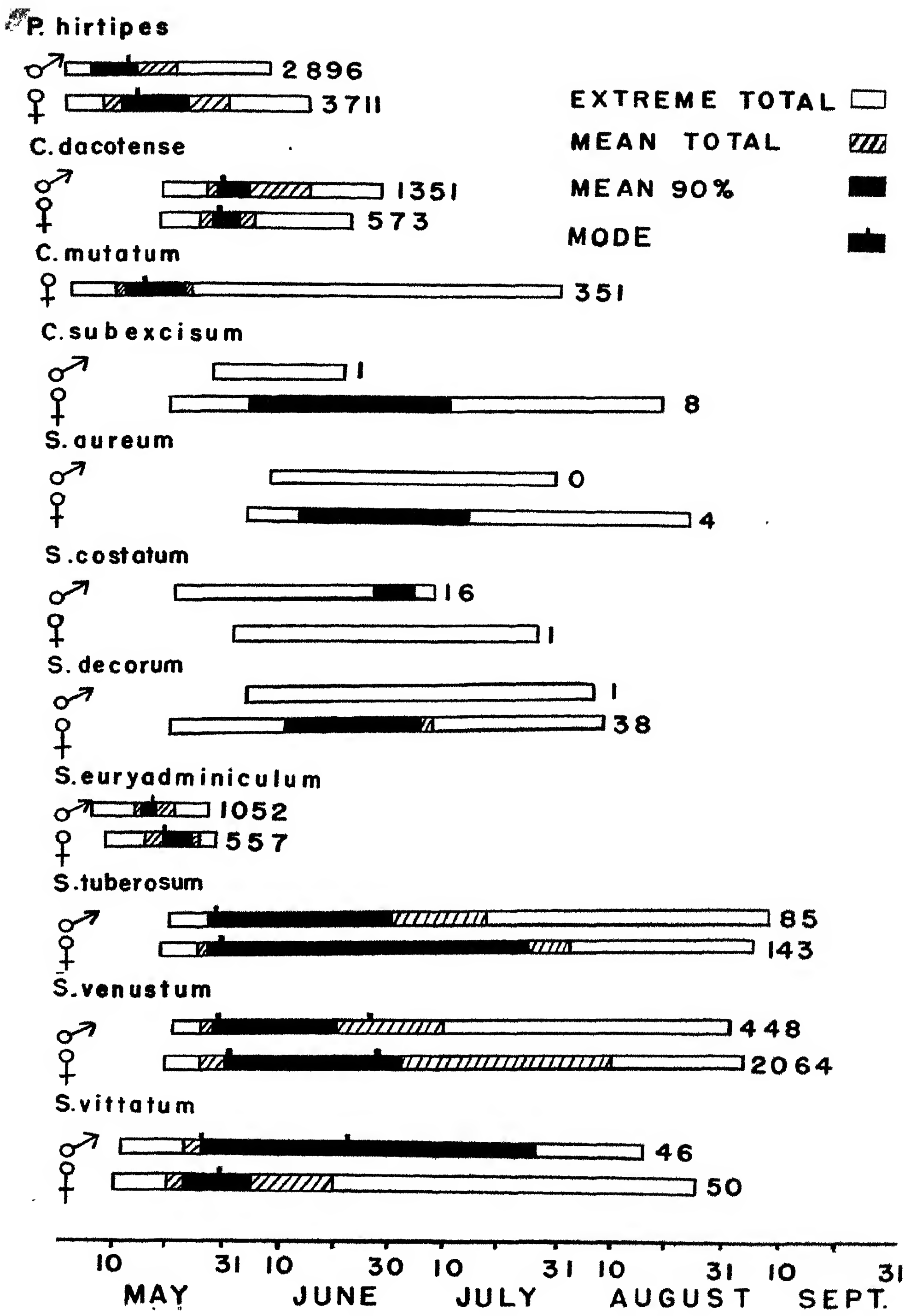

FIG. 2. The average seasonal emergence of each species by sex including the total span during 1939-1947 and the average span of total emergence, the average span of 90% emergence and the average mode for each generation for the years 1939-1944. The number of flies on which the averages are based is indicated at the end of each bar.

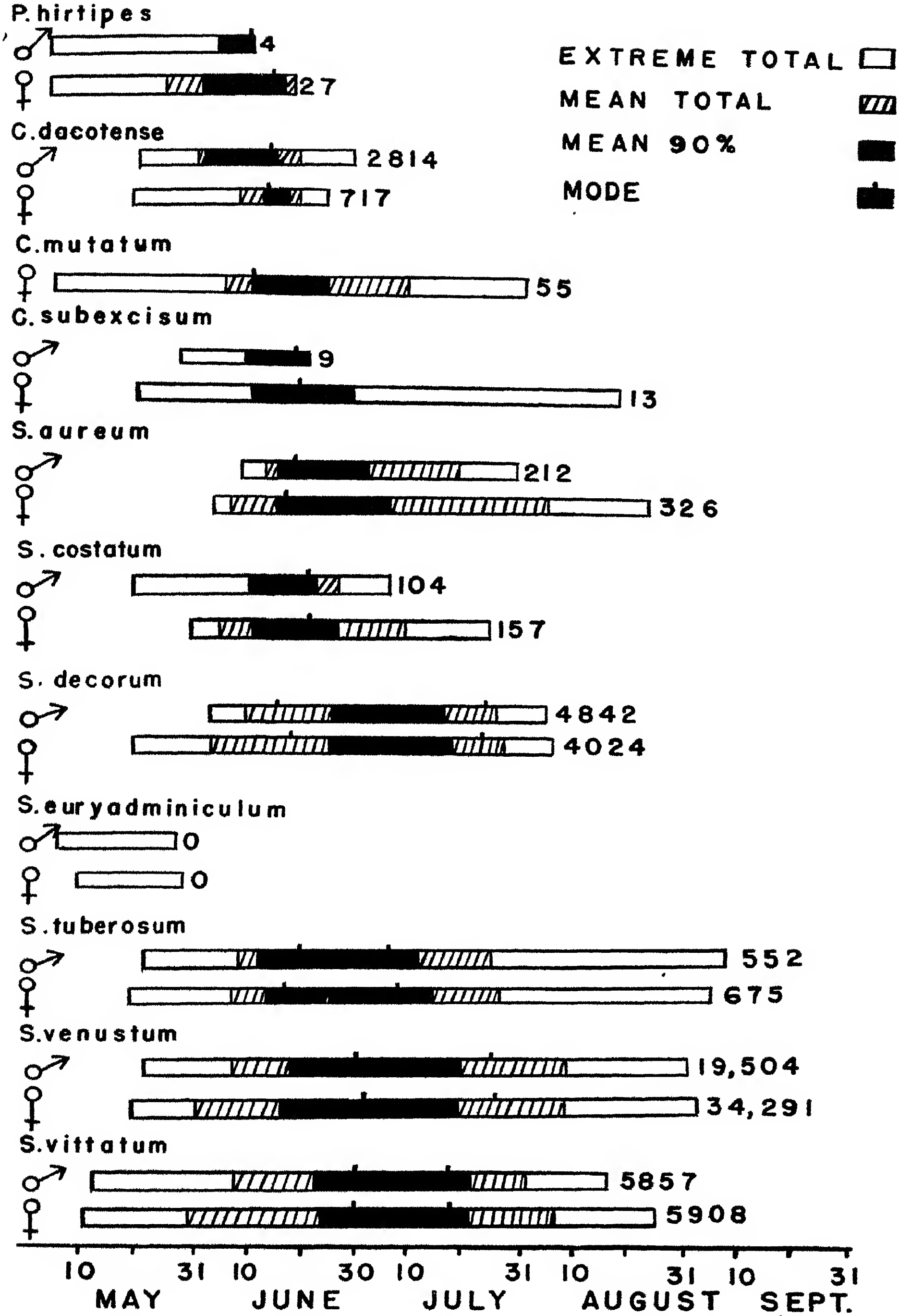

FIG. 3. The average seasonal emergence of each species by sex including the total span during 1939-1947 and the average span of total emergence, the average span of 90% emergence and the average mode for each generation (excluding the modes of the "immigrant" population) for the years 1946-1947. The number of flies on which the averages are based is indicated at the end of each bar.

(Tables IV-XIV) and the mode were later (Figs. 2 and 3). This is shown most clearly by *S. venustum* and *S. vittatum* in which the first emergence date was retarded from the last week in May, when it formerly occurred, to the end of July in 1945 in the former species and to the second week in July in the latter (Tables XI and XII). Moreover, the mode of the male emergence of *S. venustum* occurred at the beginning of June before 1944, but at the end of July in 1945, mid-July in 1946 and near the end of June in 1947.

The small size of the first generation of *S. venustum* in 1946 compared to the second contributed in part to a smaller percentage of the total emergence occurring in June in 1946 than in 1947. The first generation in 1947 was greater than the other generations. The difference between the size of the first generations in the two years may be the result of the D.D.T. treatment.

Thus, in years before 1944 the greatest emergence occurred in May owing to the predominance of the early species *P. hirtipes*, *C. dacotense* and *S. euryadminiculum*. After 1944 only a fraction of a percent of the flies emerged in May and in 1945 and 1946 fewer emerged in June than in July. In 1947 the greatest emergence occurred in June being almost twice that obtained in July. In this year, however, few black flies emerged in May, partly because the emergence of *P. hirtipes* was still small and partly because emergence of other species was not as early as it had been before 1944. This explains the change in the month of greatest total emergence after 1944 (Table II). During the years 1945-1947 there appears to be a gradual return to the biotic situation of black flies as it was before 1944.

A COMPARISON OF THE DURATION AND DATES OF EMERGENCE OF DIFFERENT SPECIES IN DIFFERENT YEARS

Various species of black flies emerged from Costello creek at different times during the season (Tables IV to XIV and Figs. 4 and 5). Scattered individuals emerged long before and after the main emergence, e.g. *S. venustum* in 1947 (Table XII). A more accurate summary of the main emergence span is obtained by subtracting 5% of the number of emerging flies from each end and also giving the date of the midpoint of emergence (i.e. the date on which half the flies of each species had emerged). Both 90% and total emergences are shown in the tables and figures. In the diagrams (Figs. 2 and 3) the modes rather than the midpoints are used in order to indicate the generations.

The earliest dates on which adults of the following species were collected from Costello creek and the mean temperature of the stream on those dates are presented below:

P. hirtipes:	May 6, 1938; 54°F.
C. dacotense:	May 23, 1942; 59°F.
C. mutatum:	May 6, 1938; 54°F.
C. subexcisum:	May 23, 1939; 54°F.
S. aureum:	June 6, 1942; 65°F.
S. costatum:	May 23, 1942; 59°F.
S. decorum:	May 22, 1942; 61°F.
S. euryadminiculum:	May 7, 1938; 52°F.
S. tuberosum:	May 20, 1942; 58°F.
S. venustum:	May 22, 1938; 57°F.
S. vittatum:	May 11, 1938; 50°F.

TABLE IV

YEARLY COMPARISONS OF EMERGENCE FROM COSTELLO CREEK

Prosimulium hirtipes (Fries)

		1938	1939	1940	1941	1942	1943	1944	1947
Number of males		44	11	181	16+	0+	2643+	1+	4
Number of females		289	27	277	35+	7+	3076+	14+	27
First date of emergence	M	6v	19v	11v	+8v	—	+21v	+27v	7vi
	F	6v	19v	13v	+8v	+21v	+21v	+24v	28v
Last date of emergence	M	24v	24v	10vi	14v	—	2vi	27v	13vi
	F	15vi	8vi	10vi	1vi	4vi	10vi	29v	20vi
Emergence span (days)	M	19	6	31	7+	—	13+	—	7
	F	41	21	29	25+	15+	21+	—	23
Total emergence span (M. and F.)		41	21	31	25+	15+	21+	—	23
First date of 90% emergence	M	6v	19v	12v	+9v	—	+21v	—	7vi
	F	11v	21v	15v	+8v	—	+22v	—	4vi
Last date of 90% emergence	M	13v	22v	2vi	11v	—	25v	—	13vi
	F	27v	6vi	3vi	23v	—	27v	—	19vi
90% emergence span (days)	M	8	4	10	3+	—	5+	—	7
	F	22	17	20	16+	—	6+	—	15
Total 90% emergence span (M. and F.)		22	19	23	16+	—	7+	—	15
Midpoint of emergence	M	11v	21v	16v	9v	—	+23v	—	11vi
	F	13v	26v	19v	11v	—	23v	—	12vi

Note: In Tables IV to XIV the date is indicated by the day of the month in Arabic and the month in Roman numerals. Also a plus sign is placed before or after the date and after the span if collections were not made early or late enough to cover the full emergence.

Although the earliest date on which adults of *P. hirtipes* were taken was May 6, pupae were collected as early as April 8, 1946 from Smith's creek at a water temperature of 36°F. Larvae, collected at the same time, pupated and adults emerged by April 20 in an aerated flask at 50°F. These dates of earliest emergence are similar to those found by Twinn (1936) in the vicinity of Ottawa, Ontario, except for *S. vittatum*, pupae of which he found as early as April 12.

P. hirtipes, *C. mutatum* and *S. euryadminiculum* were the earliest species to emerge in Costello creek, emergence beginning in early May

TABLE V

YEARLY COMPARISON OF EMERGENCE FROM COSTELLO CREEK
Cnephia dacotense (Dyar and Shannon)

		1939	1940	1942	1943	1946	1947
Number of males		14	629	509	196	2	2817
Number of females		1	373	189	8	1	716
First date of emergence	M	11vi	1vi	23v	6vi	26v	12vi
	F	11vi	2vi	22v	8vi	17vi	11vi
Last date of emergence	M	22vi	12vi	2vii	15vi	15vi	30vi
	F	11vi	10vi	2vi	13vi	17vi	27vi
Emergence span (days)	M	12	12	41	10	21	19
	F	1	9	12	6	1	17
Total emergence span (M. and F.)		12	12	42	10	23	20
First date of 90% emergence	M	11vi	3vi	24v	7vi	26v	14vi
	F	11vi	3vi	24v	8vi	17vi	15vi
Last date of 90% emergence	M	20vi	8vi	30v	13vi	15vi	22vi
	F	11vi	6vi	28v	12vi	17vi	23vi
90% emergence span (days)	M	10	6	7	7	21	9
	F	1	4	5	5	1	9
Total 90% emergence span (M. and F.)		10	6	7	7	23	10
Midpoint of emergence	M	15vi	5vi	25v	10vi	—	17vi
	F	11vi	5vi	25v	10vi	—	18vi

Note: One male and two females emerged on May 26, 1938, one male on June 14, 1941 and one on May 29, 1944.

and being completed shortly after the end of the month in most years prior to 1944, with a midpoint for the first two in late May and for the last in early June (Tables IV, VI and VIII). For 1946-1947 the average of the midpoints of emergence of *P. hirtipes* and *C. mutatum* occurred in the middle of June. *C. dacotense* was also an early species, emerging in early June before 1944 and in mid-June in 1946-1947 (Table V). *C. subexcisum*, *S. costatum* and *S. aureum* were scarcely represented before 1944 but in 1946-1947 the first two emerged during late June and in the last the midpoint of emergence was on July 1 (Tables VII, IX and X). The average date of the midpoint of *S. venustum*, *S. vittatum* and *S. tuberosum* before 1944 was early in June, but for 1946-1947 the midpoint of emergence of the first two occurred early in July, and that of the last in mid-June (Tables XI, XII, XIII). *S. decorum* emerged in early July in 1946-1947 (Table XIV) but was not found in most years before 1944. The midpoints of this species and of *S. vittatum* were a few days later than those of *S. venustum* and *S. aureum* in 1946-1947.

In most species the date of the midpoint and mode of emergence was a day or two earlier in the males than in the females. This is shown best

TABLE VI

YEARLY COMPARISON OF EMERGENCE FROM COSTELLO CREEK
Cnephia mutatum (Malloch)
Females

	1938	1939	1940	1941	1942	1943	1947
Number	171+	8	6	5	10+	149	54
First date of emergence	6v	21v	15v	10v	+21v	+21v	28v
Last date of emergence	27v+	1vi	6vi	23v	25v	2vi	4viii
Emergence span (days)	22	12	23	14	5+	13	69
First date of 90% emergence	8v	21v	15v	10v	—	22v	3vi
Last date of 90% emergence	26v	1vi	6vi	23v	—	26v	30vi
90% emergence span (days)	19	12	23	14	—	5	28
Midpoint of emergence	13v	23v	2vi	22v	—	24v	12vi

Note: Two females emerged on May 24-25, 1944 and on June 21, 1946. In 1938 all but a few isolated late emerging individuals are included.

in Fig. 3 because the number of males and females were more nearly equal, but for *P. hirtipes* and *S. euryadminiculum* Fig. 2 should be consulted. For comparison between individual years refer to Tables IV to XIV.

Differences in the length of the emergence period were found in different species. The length of the emergence period was related, in

TABLES VII and VIII

YEARLY COMPARISON OF EMERGENCE FROM COSTELLO CREEK

	Cnephia subexcisum (Edwards)			*Simulium euryadminiculum* Davies				
	1943	1946	1947	1938	1939	1940	1941	1943
Number of males	1	0	9	335	146	451	58+	62+
Number of females	4	8	5	64	178	216	12	87
First date of emergence M	31v	—	12vi	7v	21v	17v	+8v	+21v
First date of emergence F	17vi	17vi	9vi	11v	23v	19v	10v	22v
Last date of emergence M	31v	—	24vi	22v	29v	25v	10v	26v
Last date of emergence F	22vi	5viii	30vi	26v	29v	29v	16v	30v
Emergence span (days) M	—	—	13	16	9	9	3+	6+
Emergence span (days) F	6	19	22	16	7	11	7	9
Total emergence span (M. and F.)	23	19	22	20	9	13	9+	10+
First date of 90% emergence M	—	—	—	8v	22v	19v	+8v	+22v
First date of 90% emergence F	—	—	—	11v	25v	20v	20v	24v
Last date of 90% emergence M	—	—	—	13v	26v	23v	10v	25v
Last date of 90% emergence F	—	—	—	21v	27v	25v	25v	26v
90% emergence span (days) M	—	—	—	6	5	5	3+	4+
90% emergence span (days) F	—	—	—	11	3	6	7	3
Total 90% emergence span (M. and F.)	—	—	—	14	6	7	9+	5+
Midpoint of emergence M	31v	—	21vi	12v	23v	20v	10v	24v
Midpoint of emergence F	20vi	—	12vi	14v	26v	23v	14v	25v

Note: Two females emerged on May 23 and June 24, 1939; one on June 13, 1940 and one on August 22, 1942.

Note: In 1941 and 1943 all but a small portion of the early emergence of males was taken.

part, to the number of generations in a species. *P. hirtipes, C. dacotense, C. mutatum* and *S. euryadminiculum* appeared to have one generation per year, whereas the other species had two or more. The average emergence span was thirteen days for species having one generation, and thirty-two days for those having two or more generations.

TABLES IX and X

YEARLY COMPARISON OF EMERGENCE FROM COSTELLO CREEK

		Simulium aureum Fries		*Simulium costatum* Frieds.		
		1946	1947	1943	1946	1947
Number of males		30	182	13	4	100
Number of females		58	268	1	3	154
First date of emergence	M	11vi	21vi	3vi	17vi	11vi
	F	9vi	9vi	4vi	16vi	3vi
Last date of emergence	M	12vii	2viii	24vi	21vi	10vii
	F	20vii	27viii	4vi	27vi	29vii
Emergence span (days)	M	32	43	22	5	30
	F	42	80	1	12	57
Total emergence span (M. and F.)		42	80	22	12	57
First date of 90% emergence	M	12vi	23vi	3vi	17vi	12vi
	F	10vi	24vi	4vi	16vi	13vi
Last date of 90% emergence	M	11vii	30vi	18vi	21vi	1vii
	F	13vii	5vii	4vi	27vi	3vii
90% emergence span (days)	M	30	8	16	5	20
	F	34	12	1	12	21
Total 90% emergence span (M. and F.)		34	13	16	12	22
Midpoint of emergence	M	6vii	28vi	—	19vi	23vi
	F	7vii	28vi	—	20vi	28vi

Simulium aureum — Note: One female emerged on June 27, 1939, one on July 25, 1940 and two on June 6 and July 28, 1942.

Simulium costatum — Note: One female emerged on June 18, 1939, one male on June 3, 1940 and two males on May 23-24, 1942.

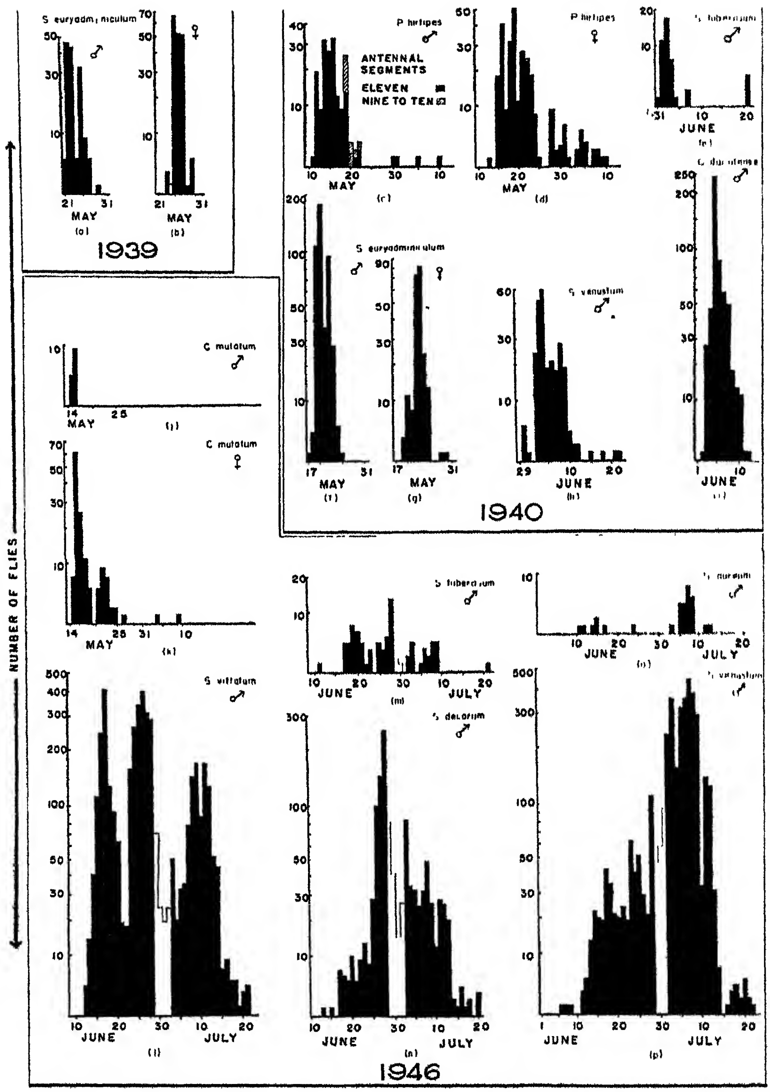

FIG. 4a-p. Number of males and females of different species emerging daily throughout the year from a square yard of stream bottom, plotted on a semilogarithmic scale. All emerged from Costello creek except for *C. mutatum* in 1946 which was collected from Smith's lake inlet.

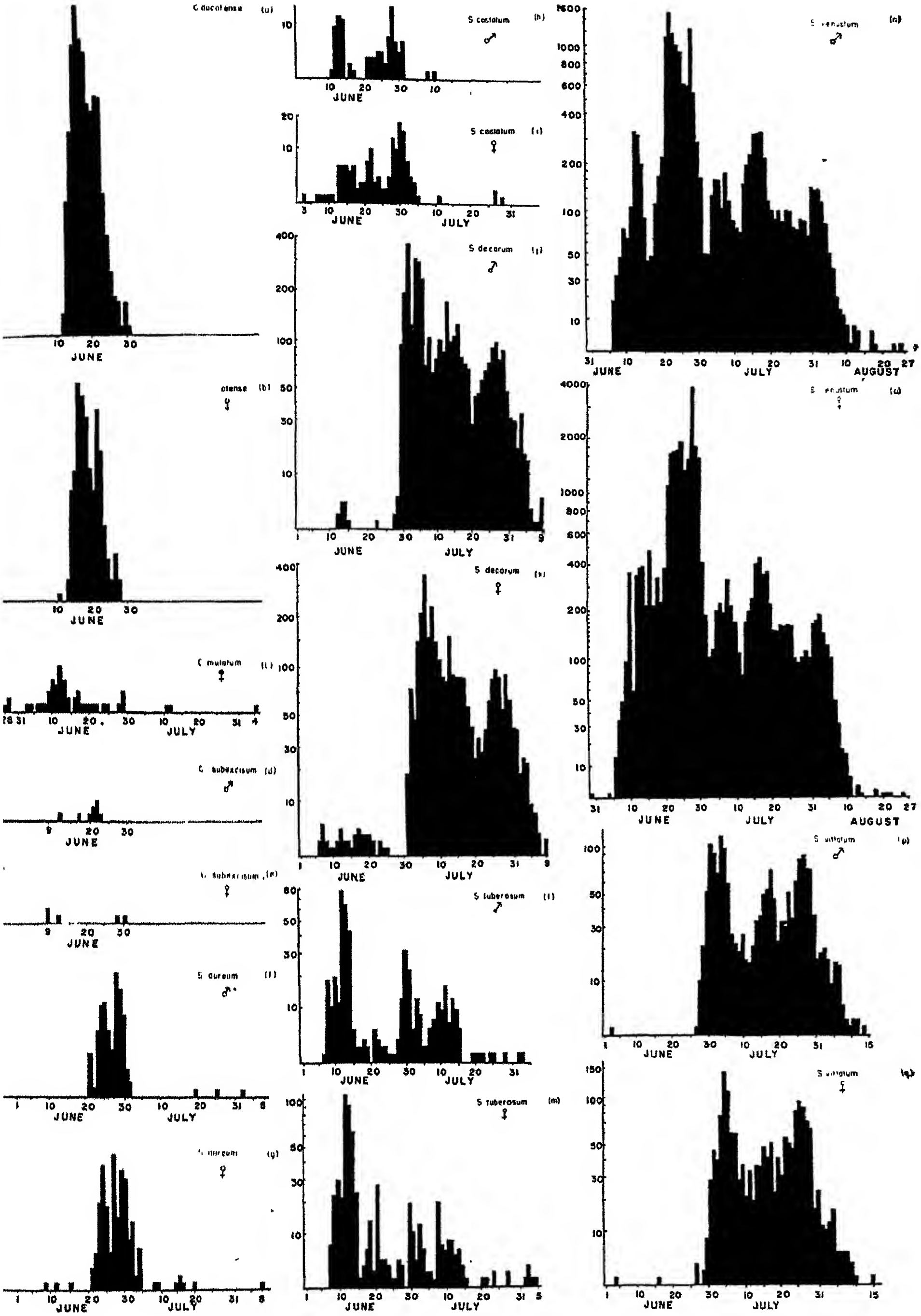

Fig. 5a-q. Number of males and females of different species emerging daily during 1947 from a square yard of Costello creek, plotted on a semilogarithmic scale.

Species showed different characteristics of emergence. *P. hirtipes* had a less sharply peaked emergence than *C. dacotense* and *S. euryadminiculum* (Figs. 4a-d, f, g, i and 5a, b) so that the average span of 90% emergence was 19 days in the former and 10 and 8 days respectively in the latter two.

THE NUMBER AND CHARACTER OF GENERATIONS OF EACH SPECIES IN A YEAR

A study of the number and character of generations occurring in each species was made by plotting on semilogarithmic graph paper the

TABLE XI

YEARLY COMPARISON OF EMERGENCE FROM COSTELLO CREEK
Simulum vittatum Zetterstedt

		1938	1942	1943	1944	1945	1946	1947
Number of males		2+	6	35	1+	13	4075	1782
Number of females		5+	4	36	3+	16	4214	1694
First date of emergence	M	12v	6vI	24v	24v	9vII	12vI	3vI
	F	11v	22v	24v	24v	12vII	11vI	17v
Last date of emergence	M	13v+	10vII	27vI	24v+	17vIII	21vII	14vIII
	F	23v+	11vI	7vII	26v+	23vIII	22vII	26vIII
Emergence span (days)	M	—	35	35	—	10	40	73
	F	—	21	45	—	43	42	102
Total emergence span (M. and F.)		—	50	45	—	46	42	102
First date of 90% emergence	M	—	6vI	24v	—	9vII	16vI	30vI
	F	—	22v	24v	—	12vII	17vI	2vII
Last date of 90% emergence	M	—	10vII	26vI	—	17vIII	12vII	1vIII
	F	—	11vI	2vI	—	23vIII	13vII	1vIII
90% emergence span (days)	M	—	35	34	—	40	27	33
	F	—	21	10	—	43	27	31
Total 90% emergence span (M. and F.)		—	50	34	—	46	28	33
Midpoint of emergence	M	—	13vI	30v	—	20vII	26vI	61vII
	F	—	7vI	29v	—	17vII	28vI	17vII

Note: One male emerged on May 22, 1939, one male on May 25, 1939, one male on June 18, 1940 and one female on June 13, 1941.

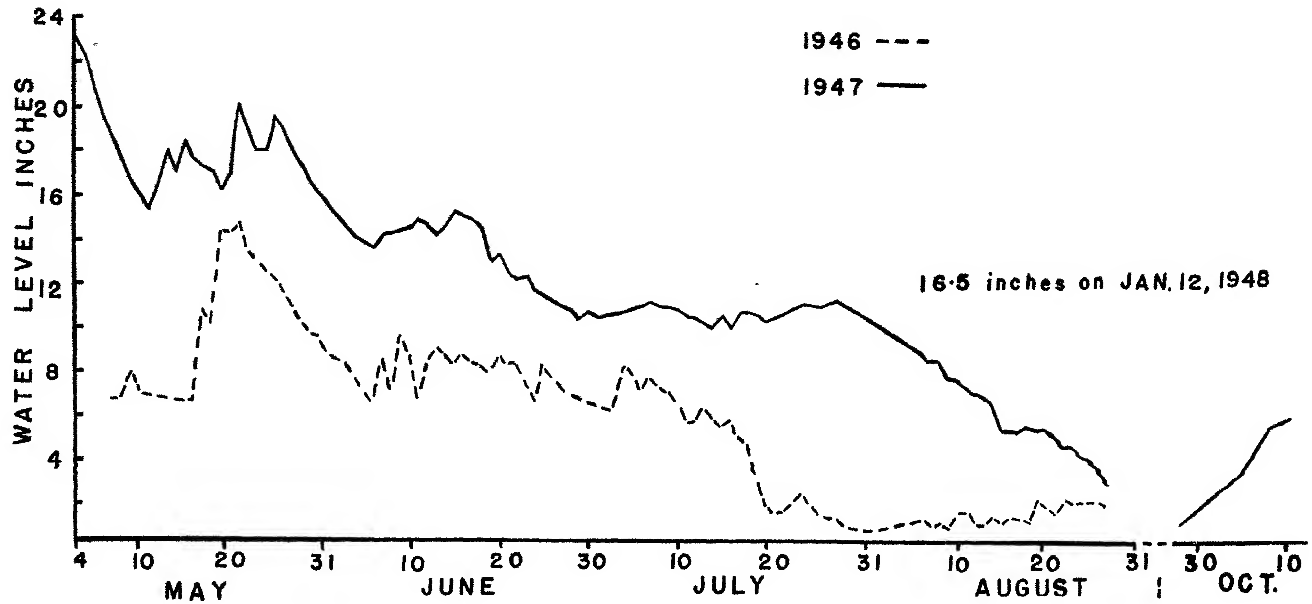

FIG. 6. Seasonal variation in the water level for the years 1946 and 1947 in Costello creek.

number of flies emerging from Costello creek against time in days (Figs. 4 and 5). The graphs for the years 1940, 1946 and 1947 were used because in these years the largest number of species and individuals emerged and collections were made for the most extensive periods. Graphs of the emergence of *S. euryadminiculum* in 1939 (Fig. 4a, b) and of *C. mutatum* from Smith's lake inlet in 1946 (Fig. 4j, k) were included to give a more complete picture.

(a) *Species with one annual generation*

P. hirtipes, *C. mutatum*, *C. dacotense*, *S. euryadminiculum* and probably *C. subexcisum* had only one generation per year in all the years studied (Figs. 4a-d, f, g, i-k and 5a-e), the eggs of the first two hatching in the fall after remaining dormant during the summer and those of the third hatching in the spring after a summer and winter dormancy. *C. mutatum* in 1938 was the only exception appearing to have two generations, the first from May 6-19 and the second, of smaller individuals, from May 23-27 or later. The observation on *P. hirtipes* confirms the work on this species by Strickland (1913) and Johannsen (1934) in the United States of America and Smart (1936) in Scotland. No records were found for the number of generations in the three other species. However, Bradley (1935) reported that *Cnephia pecuarum* (Riley) of the same genus as *C. dacotense* and *C. mutatum* had only one generation in the states of Mississippi and Arkansas, U.S.A.

(b) *Species with more than one annual generation*

(1) *S. venustum:* This species was chosen to represent this type of life cycle because it emerged in greatest numbers and most information had been gathered for all its stages.

In 1940 there appeared to be two generations, the first large and the second small (Fig. 4h). The size of the latter was related in part to low temperature of the air in mid-June which curtailed oviposition.

More data were collected in 1947 and these showed the number and interrelation of generations better than in other years. Emergence continued longer than in 1946 and was related apparently to the higher water level during July and August in 1947 than in 1946 (Fig. 6). This resulted from the heavier rainfall during these months in 1947.

Five peaks of emergence, more distinct for the males, are apparent in 1947 (Fig. 5n, o), but these represent probably only three generations. The first "native" generation comprised the first three peaks. It resulted from eggs which were presumably in the stream all winter. First instar larvae appeared on May 5 for the first time that year, and emergence of males began on June 6 (Fig. 5n, and Table XII). The summation of the daily mean temperatures (°F.) of the water (averages of the

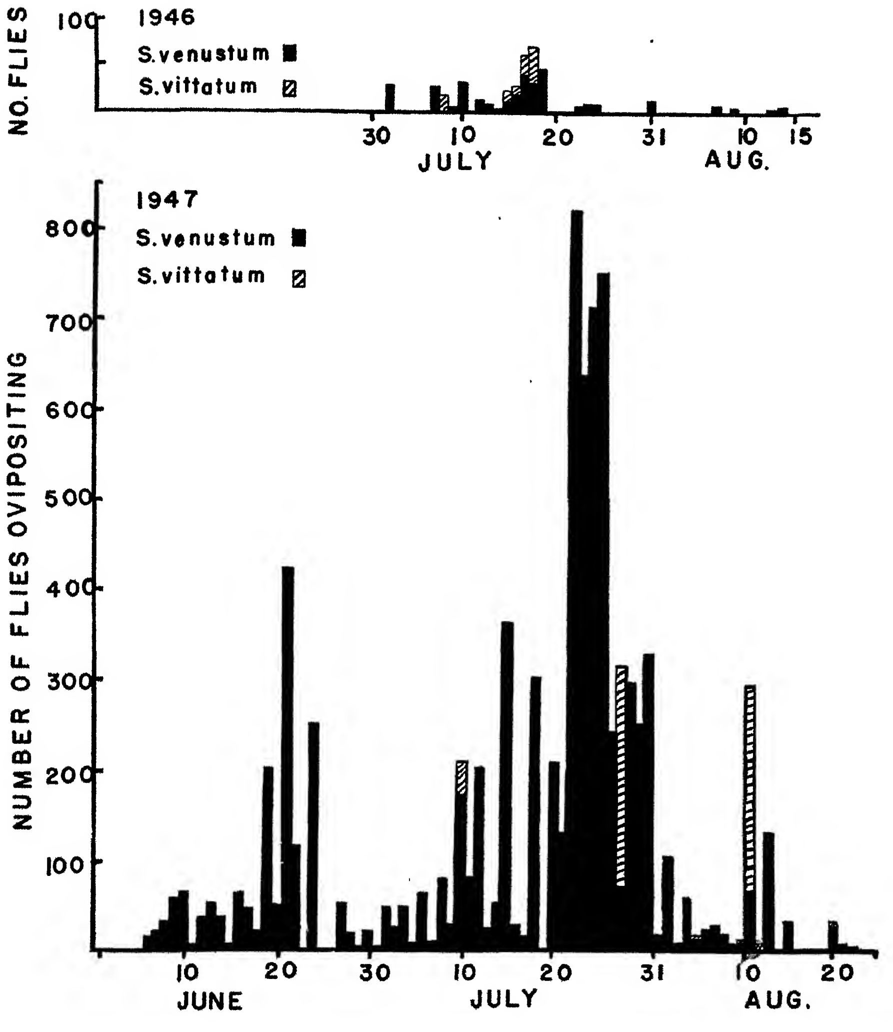

FIG. 7. Number of flies ovipositing daily during 1946 and 1947 in Costello creek.

daily maximum and minimum temperatures) during this period was 1511, the number of day degrees required for development of the larvae and pupae of *S. venustum*. This figure is higher than if only the effective temperatures for growth were considered, but is used because the upper and lower thermal thresholds for development of this species are not known.

Oviposition was observed on June 6 (Fig. 7), presumably by females which had emerged from other streams at an earlier date, because the eggs of newly emerged females of this species are undeveloped. The eggs of these immigrant females hatched after seven days in moist vials in the laboratory at an average temperature of approximately 60°F. and probably hatched in about the same time in the stream because the temperature of the water averaged 60°F. during the six days following first oviposition. These immigrant females would then produce a second generation of adults which would begin emerging about July 6 on the basis of the same summation figure of 1511 day degrees. This explains the fourth peak of emergence.

The females of the first "native" generation should contain mature eggs approximately eighteen days after emergence, consequently they would begin oviposition about June 21 and the adults of the resulting second "native" generation would be emerging about July 20 which date coincides with the fifth peak of emergence. These adults would return to oviposit about August 5. The adults of the second generation of immigrant flies would return to oviposit about July 23. The last of the first "native" generation might still be laying eggs when the second oviposition of the "immigrant" population began, giving this large second peak of oviposition (Fig. 7).

As little emergence occurred after August 13 and few larvae were in the stream, it appears that most of the eggs laid by the second generation females in both the "immigrant" and "native" populations did not hatch immediately. Only a few first instar larvae were found on July 24. It appears that most of the eggs of each second generation enter a state of diapause which continues throughout the latter half of the summer, fall and winter, and that hatching of these eggs does not occur until late April or early May of the following year. This is supported by the failure to find pupae or more than occasional larvae of this species after extensive searches in Costello creek on April 8 and November 28, 1946, on May 4, 1947 and on January 12, 1948 and by finding first instar larvae on May 5, 1947. Occasional larvae of this species, and also of *S. vittatum* developed during the winter and emerged as adults before the main emergence.

The pattern of "native" and "immigrant" generations mentioned above is illustrated in Fig. 8 showing the approximate dates of oviposition,

hatching and emergence and the approximate number of days taken for incubation, larval and pupal development and growth of eggs in the female. The length of each of the generations, from the hatching of the egg to the next oviposition was 50, 41 and 38 days respectively. The diagram represents an over-simplification, as immigrant flies would continue to oviposit from June 6 throughout the rest of the spring and early summer, judging by their emergence in other localities. It is considered valid, however, because the number of immigrants, except in the earliest case, was small as compared with the "native" population.

The immigrant females, which began oviposition in Costello creek on June 6, probably emerged from neighbouring streams two to three weeks

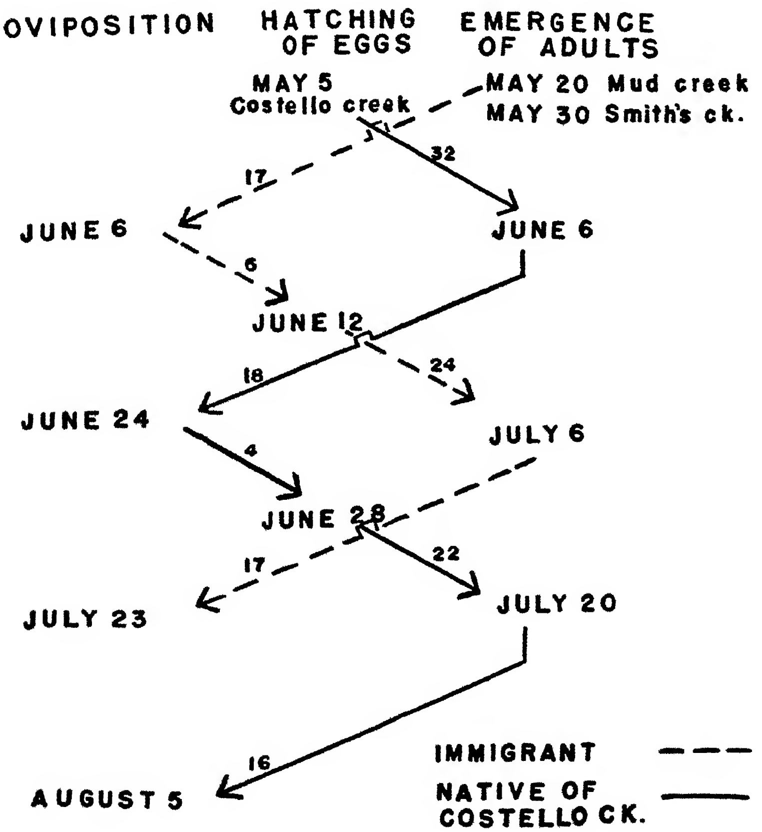

FIG. 8. The sequence of "native" and "immigrant" generations of *S. venustum* in 1947 in Costello creek. The first dates of oviposition, hatching of eggs and emergence of adults are given and in small numerals the number of days for each period.

previously and migrated, or were carried by the wind, from their original stream. Smith's creek and Mud creek, three to five miles away, are examples of streams with an earlier emergence than Costello creek. Empty pupal skins of *S. venustum* were collected from Mud creek on May 20. At Smith's creek the first *S. venustum* males in the cage collections emerged on May 30. A comparison of the daily mean temperature of Smith's creek and Costello creek indicated that there was a higher temperature in the former from May 4 to June 6. The temperature of Mud creek was also higher than that of Costello creek during the same period.

In 1947 then, there were populations at Costello creek derived from two different localities, each population having two generations. The occurrence of two generations of *S. venustum* in Costello creek is in agreement with Forbes (1912) who said that this species had two or more generations in Illinois, although Jobbins-Pomeroy (1916) reported three to four generations for this species in Illinois and five or six in South Carolina. It seems probable that the larger number of generations reported by these authors may be actually a result of different populations as described above.

In 1946 there were two generations only, the first large and prolonged, and the other small (Fig. 4p) and the situation did not appear to be complicated by immigration. Using the same day degree summation, 1511 day degrees, as found in 1947, the first instar larvae would have appeared by May 10 as emergence began June 6, 1946. It is unlikely that the hypothetical larvae of May 10 could have hatched from eggs laid by immigrant females, as adults did not begin emergence from Smith's creek until May 23, 1946. Also, few immigrant flies were seen in the vicinity before emergence began at Costello creek owing partly to the dry season. We have the following pattern of generations for 1946: hatching of over-wintering eggs on May 10, beginning of emergence on June 6, beginning of oviposition on June 19, hatching of second generation eggs on June 24, beginning of second emergence on July 16 and beginning of second oviposition on August 2. The length of these two generations from the hatching of the egg to the next oviposition was forty and thirty-nine days respectively. Most of these figures and dates are of necessity only approximate but they indicate the general pattern of the life cycle of *S. venustum* in Costello creek. There may have been a few immigrant females ovipositing throughout the period which have not been considered in the analysis of 1946. There was an interruption of three days in the collecting, from June 27—July 1, so that when the emergence of four days was collected on July 2 there were fewer flies than if daily collections had been made.

TABLE XII
YEARLY COMPARISON OF EMERGENCE FROM COSTELLO CREEK
Simulium venustum Say

		1938	1939	1940	1941	1942	1943	1944	1945	1946	1947
Number of males		35+	8	259	0	63	74	9+	3	3683	15,821
Number of females		26+	177	590	70	212	936	53+	36	5496	28,795
First date of emergence	M	22v	31v	30v	—	23v	30v	25v	28vii	11vi	6vi
	F	22v	2vi	29v	20v	20v	30v	+24v	14vi	5vi	29v
Last date of emergence	M	27v+	1ix	22vi	—	10vi	7vii	29v+	21viii	22vii	26viii
	F	27v+	31x	29vii	27vii	15vii	31x	30v+	15viii	22vii	26viii
Emergence span (days)	M	—	94	24	—	19	39	—	25	42	82
	F	—	94	62	69	56	97	—	63	48	90
Total emergence span (M. and F.)		—	98	62	69	56	97	—	69	48	90
First date of 90% emergence	M	—	31v	2vi	—	24v	31v	—	28vii	25vi	13vi
	F	—	5vi	3vi	26v	22v	4vi	—	21vi	20vi	14vi
Last date of 90% emergence	M	—	1ix	9vi	—	31v	13vi	—	21viii	11vii	31vii
	F	—	28vi	18vii	14vii	13vi	6vii	—	9viii	12vii	28vii
90% emergence span (days)	M	—	94	8	—	8	14	—	25	17	49
	F	—	24	46	50	23	33	—	50	23	45
Total 90% emergence span (M.&F.)		—	94	47	50	23	37	—	62	23	49
Midpoint of emergence	M	—	27vi	4vi	—	28v	4vi	—	10viii	6vii	26vi
	F	—	11vi	7vi	13vi	25v	11vi	—	26vi	6vii	27vi

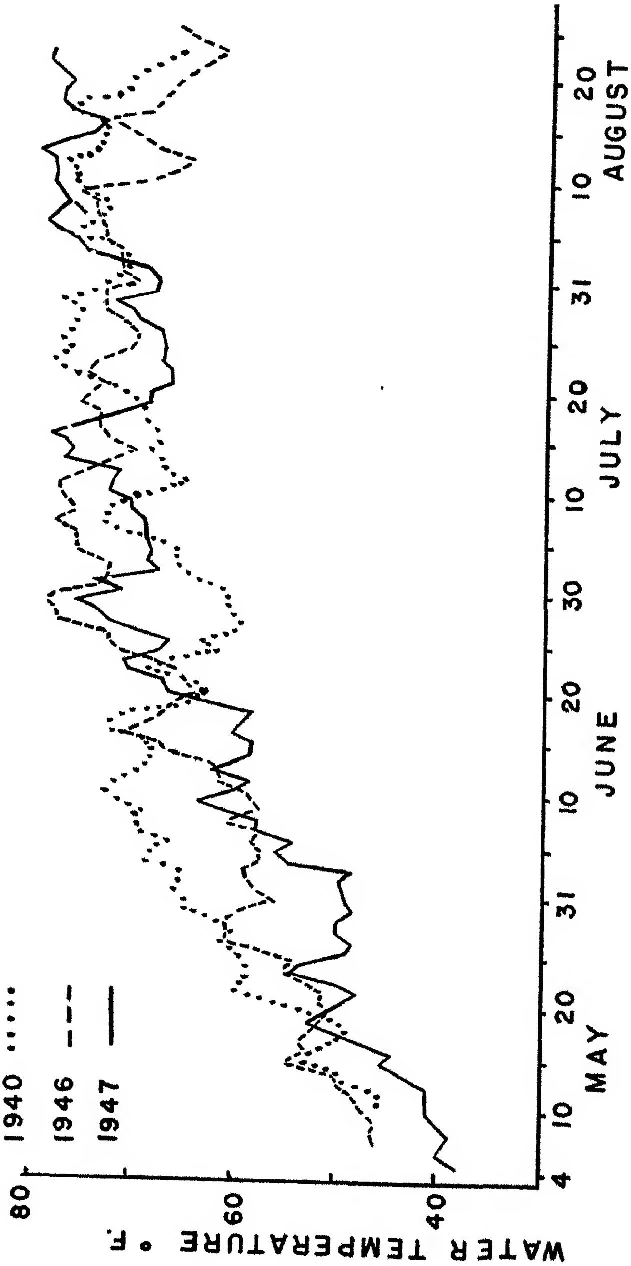

FIG. 9. Seasonal variation in daily mean water temperature (average of daily maximum and minimum) for the years 1940, 1946 and 1947 in Costello creek.

The large emergence of the first generation in 1947 is surprising considering the probable small number of over-wintering eggs from the oviposition of the small second generation in 1946. It may be the result of at least two factors: (a) environmental conditions in 1947 were so favourable that there was a low mortality in the over-wintering eggs and developing larvae and, (b) a portion of the first generation females in 1946 may also have laid eggs which went into diapause over winter.

The minor peaks and depressions in the number of emerging flies followed by a day or two similar changes in the daily mean water temperature (Fig. 9). In 1947 it can be seen that though the peak of emergence of a generation may be delayed by low temperature, it will express itself eventually even if the temperature does not increase greatly. This peak will be less sharp, however, extending over a long time interval, e.g. fourth peak Fig. 5n. The emergence of the second "immigrant" generation, represented by the fifth peak, dropped rapidly to two flies by August 11. This cannot be explained by a drop in temperature, but may be the result of the deleterious effect of high temperature as maximum water temperatures of over 80°F. occurred after August 4. Underhill (1944) suggests that water temperatures over 80°F. were detrimental to the aquatic stages of *S. jenningsi* Malloch (=*S. nigroparvum* Twinn). Rajindar (1945) in India says that high temperature, although below the lethal point, greatly retarded the development of *Anopheles culicifacies* Giles from the egg to the adult. The continually dropping water level in Costello creek (Fig. 6), especially in the last half of July in 1946 causing the desiccation of the eggs and pupae may have contributed as well to this decline in emergence. The reduction in emergence may have been caused also by the increased number of net-building caddisflies, of the family Hydropsychidae (Order: Trichoptera) in the stream. These have been reported as preying on the black fly larvae and pupae by Howard (1888), Jobbins-Pomeroy (1916), Twinn (1939), Muttkowski (1929) and Muttkowski and Smith (1929) in North America. In England, Miall (1895) stated that caddis-worms were the commonest and the most formidable enemy of the black fly.

(2) *S. tuberosum:* In 1946 there were possibly two generations of this species, but the second was less distinct. Males of the first generation began to emerge on June 11 continuing until June 30 and the second generation emerged from July 2-21 (Fig. 4m). Again minor depressions in numbers are associated with a temperature decline one or two days before emergence (Fig. 9). In 1947, there were two large generations, a "native" and an "immigrant" generation, with possibly a small second "native" generation about the end of July (Fig. 5l, m). The emergence of the first "native" generation in the male extends from June 6-25, the first "immigrant" from June 25—July 15 and the second "native" from

July 19—August 3. The emergence of females in both years differed from that of the males by a few days only. In 1940 (Fig. 4e) one generation emerged in early June with a few individuals of possibly a second generation in late June. *S. jenningsi*, part of which Dyar and Shannon (1927) considered as *S. tuberosum* (=*S. perissum*), had 5-6 generations in South Carolina (Jobbins-Pomeroy 1916).

(3) *S. decorum:* It is difficult to distinguish the generations in this species in 1946 (Fig. 4n), although it appears that there were two over-

TABLE XIII

YEARLY COMPARISON IN EMERGENCE FROM COSTELLO CREEK
Simulium tuberosum (Lundstroem)

	1939	1940	1941	1942	1943	1945	1946	1947
Number of males	2	43	1	24	14	0	79	473
Number of females	1	27	9	82	20	4	119	556
First date of M emergence F	19vi 6ix	31v 2vi	1viii 25v	22v 20v	2vi 2vi	— 8vii	11vi 9vi	7vi 8vi
Last date of M emergence F	15viii 6ix	9ix 1vii	1viii 7ix	30v 19viii	7vi 21viii	— 24viii	9vii 21vii	14viii 5viii
Emergence M span (days) F	58 1	102 30	1 106	9 92	6 81	-- 48	29 43	69 59
Total emergence span (M. and F.)	80	102	106	92	81	48	43	69
First date of M 90% emergence F	19vi 6ix	1vi 2vi	1viii 25v	22v 24v	2vi 3vi	— 8vii	17vi 19vi	9vi 9vi
Last date of M 90% emergence F	15viii 6ix	21vi 1vii	1viii 7ix	26v 30vii	7vi 10viii	— 24viii	9vii 18vii	14vii 12vii
90% emergence F span (days) F	58 1	21 30	1 106	5 68	6 69	— 48	23 30	36 34
Total 90% emergence span (M. and F.)	80	31	106	70	70	48	32	36
Midpoint of M emergence F	— —	2vi 4vi	— —	24v 6vii	3vi 7vi	— —	28vi 28vi	14vi 13vi

Note: Two females emerged on May 25, 1938, one male on May 25, 1944 and two females on May 27-28, 1944.

lapping generations from June 12—July 14 and July 12-20. In 1947 there were probably one "immigrant" and two "native" generations as judged by the histograms of emergence (Fig. 5j, k). The emergence of the first "native" generation was small, occurring from June 12-23 in the males and from June 6-25 in the females. The first "immigrant" and second "native" generations overlapped and were hard to distinguish. In the males the first "immigrant" generation extended from June 27—July 25 and the second "native" generation from July 15—August 9 and in the females, July 1-25 and July 15—August 9. In 1940 only a few females emerged late in the season. No previous records of the number of generations of this species were found.

TABLE XIV

Yearly Comparison of Emergence From Costello Creek
Simulium decorum Walker

		1939	1940	1941	1942	1945	1946	1947
Number of males		1	0	0	0	0	1139	3703
Number of females		4	3	9	17	16	912	3112
First date of emergence	M	5vi	—	—	—	—	13vi	12vi
	F	5vi	29vii	31v	22v	29vi	7vi	6vi
Last date of emergence	M	5vi	—	—	—	—	20vii	8viii
	F	20vii	6viii	16vi	23vii	31vii	22vii	9viii
Emergence span (days)	M	1	—	—	—	—	38	58
	F	46	9	17	63	33	46	65
Total emergence span (M. and F.)		46	9	17	63	33	46	65
First date of 90% emergence	M	5vi	—	—	—	—	24vi	1vii
	F	5vi	29vii	31v	23v	9vii	24vi	3vii
Last date of 90% emergence	M	5vi	—	—	—	—	11vii	30vii
	F	20vii	6viii	16vi	16vi	31vii	12vii	31vii
90% emergence span (days)	M	1	—	—	—	—	18	30
	F	46	9	17	25	23	19	29
Total 90% emergence span (M. and F.)		46	9	17	25	23	19	31
Midpoint of emergence	M	—	—	—	—	—	28vi	9vii
	F	—	—	14vi	2vii	19vii	4vii	11vii

Note: One female emerged on May 23, 1938, two on July 15 and 24, 1943 and two on May 24-25, 1944.

(4) *S. vittatum:* In 1946 there were apparently two overlapping generations, the first from June 11—July 5 and the second from June 30—July 22, although there were three well-defined peaks (Fig. 4l). The depression between the first two peaks followed closely a drop in water temperature (Fig. 9) and as the temperature rose so did the number of emerging flies. However, before the highest temperature of the season was reached the numbers began to decline. The second depression in the histogram of emergence was coincident again with a low daily mean temperature and the following large emergence with a rise in temperature.

In 1947 there were probably only two generations (Fig. 5p, q), although three peaks were present, most pronounced in the males. The second generation was of longer duration owing to several days of low temperature (Fig. 9), before it had reached peak numbers. Thus, a depression of the numbers of emerging flies resulted for a time, but eventually a large portion of the flies emerged in spite of the low temperature. The first generation emerged from June 27—July 19 and the second from July 14—August 15 approximately. There was possibly another small generation in August, although this was obscured somewhat by the last of the large second generation. The reason for the emergence continuing three weeks longer in 1947 than in 1946 is at least partly a result of the higher water level (Fig. 6) which extended favourable conditions for a large number of individuals to a later date than in other years.

The number of generations found in the present study is in agreement with the findings of Forbes (1912) who said this species had two or more generations in Illinois, U.S.A. However, in the warmer climate of South Carolina there may be five to six generations (Jobbins-Pomeroy 1916).

(5) *S. aureum:* In 1946 there were apparently two generations of this species. The males emerged from June 11-24 and July 3-13 (Fig. 4o), and the females from June 9-23 and July 3-20. There were probably two generations in 1947 from June 20—July 2 and July 8-20, but the second was small and indistinct (Fig. 5f, g). Jobbins-Pomeroy (1916) speaks of 5-6 generations in this species in South Carolina, U.S.A. Near Paris, France, *S. aureum* has two generations according to Pacaud (1942).

(6) *S. costatum:* This species was found in numbers in 1947 only and appeared to have two generations (Fig. 5h, i). The first "native" generation occurred from June 11-17 for males and June 3-25 for females and the second possibly from eggs of "immigrant" females from June 21—July 10 and June 23—July 4 for males and females respectively. There was also an indication of another generation, shown in the emergence of the females, from July 27-29, which may have been the second

generation of the "native" population. Grenier (1945) near Paris, France, stated that, although *S. costatum* was thought previously to have two generations, one in the spring and one in September, there are probably two generations in the spring.

HOURLY EMERGENCE

Various forms of aquatic insects emerge at different times of the day or night. In order to learn of the emergence habits of the different black fly species, collections were made at one or two hour intervals throughout a period of twenty-four hours or longer at different times during the season. Data on the hourly emergence of each of nine species are shown graphically in Fig. 10 and summarised in Fig. 11.

Black flies emerged throughout the whole day and part of the night. Ninety percent of all emergence occurred from 4:30 a.m. to 9:45 p.m. with a peak of emergence at about 9:25 a.m., that for the females being 50 minutes later than that for the males. Only occasional flies emerged from 10:45 p.m. to 3:15 a.m. The average midpoint was at 11:20 a.m. with little difference between the sexes.

C. dacotense and then *S. venustum* showed the longest periods for 90% emergence (Fig. 11). *C. dacotense* emerged in more uniform numbers than other species throughout the day (Fig. 10c, d) and had a long daily span of emergence which may be related to its short, sharp seasonal emergence. The mode of diurnal emergence for *S. venustum* occurred later in the day as the season progressed for which no apparent reason was found. *C. mutatum* emerged in small numbers, but there were indications that the emergence of the females was similar to that of *P. hirtipes*. The sequence of species as judged by the average midpoints of emergence was as follows, beginning with the earliest: *S. venustum*, *C. dacotense*, *S. vittatum*, *S. tuberosum*, *S. decorum*, *S. costatum*, *P. hirtipes*, *C. mutatum* and *S. aureum*.

The largest hourly emergence, in all species except *S. aureum*, did not coincide with or even follow the water temperature peak for the day. In most cases the emergence started before the water temperature began to rise after the early morning minimum. It may be that, in most cases, certain processes in preparation for emergence were operating during the night and that the advent of light stimulated emergence.

The number of adults of *S. venustum* emerging hourly on June 28, 1947 (Fig. 10o) was apparently related to the intensity of light throughout the day. This intensity rose sharply at 5:15 a.m. to over 1600 units on the exposure meter. At this time the flies began to emerge and the number per hour increased until just before noon when the light intensity was near its daily maximum. As the intensity decreased the number of emerging flies decreased noticeably. At 6 p.m. the intensity dropped

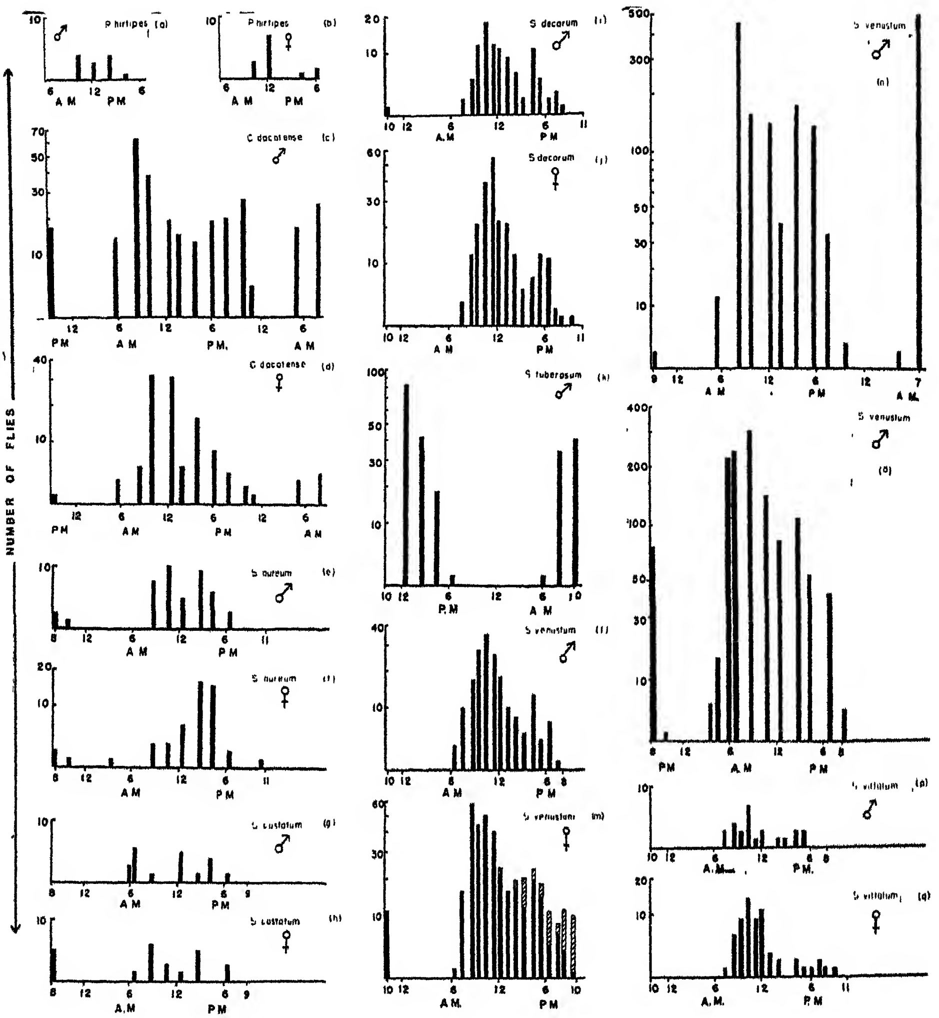

FIG. 10a-q. Number of males and females of different species emerging hourly from a square yard of stream bottom. All emerged from Costello creek except for *P. hirtipes* from Smith's creek and *S. tuberosum* from Tea lake dam, Oxtongue river. The hatching in 'm' refers to flies which forced themselves through the screening.

a, b. - - - - - 6:15 a.m. to 8:15 p.m. May 23, 1947
c, d, n. - - - - 9:00 p.m. June 20 to 7:05 a.m. June 22, 1947
e, f, g, h, o. - - 7:40 p.m. June 27 to 4:20 a.m. June 29, 1947
i, j, l, m, p, q. - 9:55 p.m. July 7 to 10:30 p.m. July 8, 1947
k. - - - - - - - - 10:30 a.m. July 8 to 10:00 a.m. July 9, 1940
Note: This collection of *S. tuberosum* was discussed by Ide (1942).

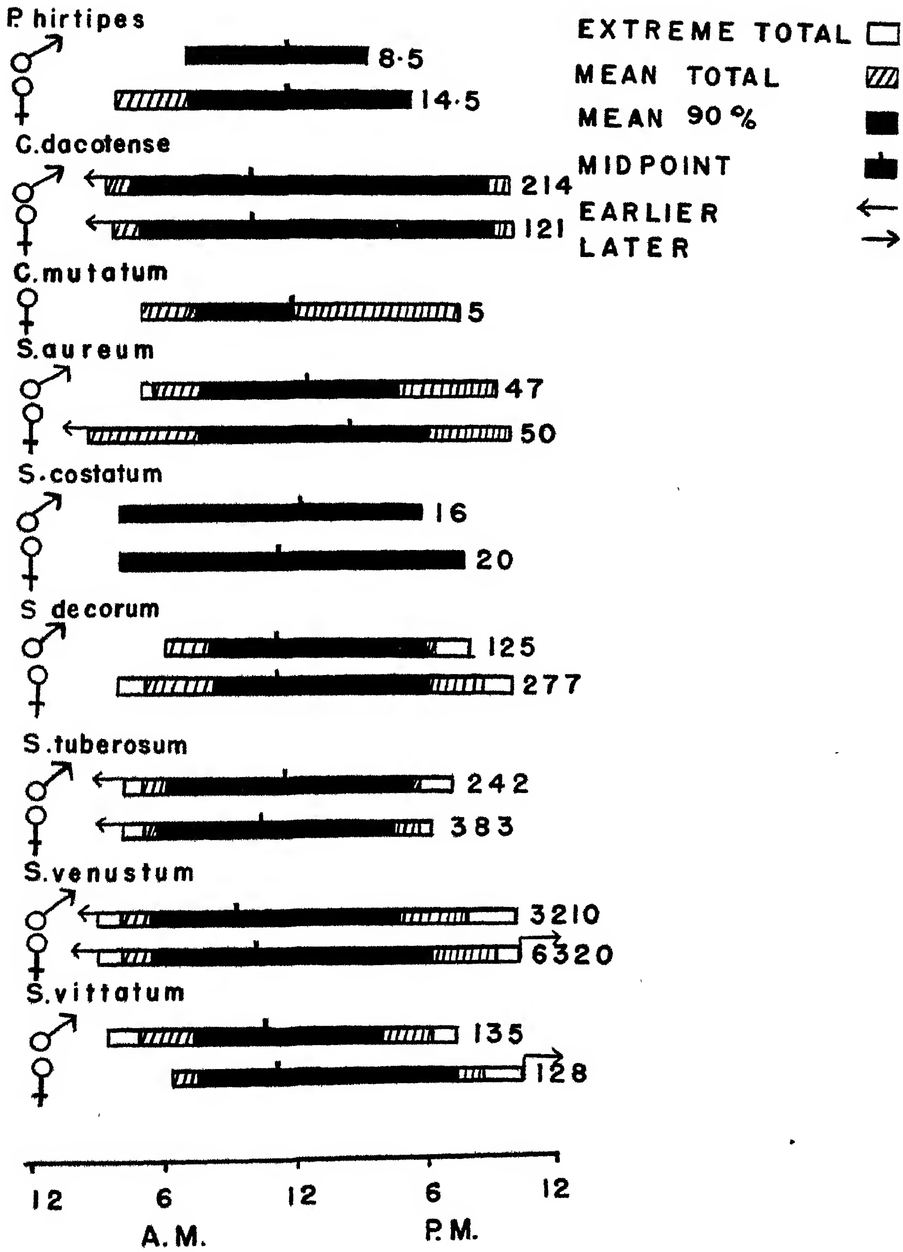

FIG. 11. The average emergence of each species per hour in a twenty-four hour period showing the extreme span of emergence, the average span of total emergence, the average span of 90% emergence and the average midpoint. The number of flies on which the averages are based is indicated at the end of each bar.

sharply and shortly thereafter only occasional flies emerged. Also, on June 21, 1947 the peaks in hourly emergence of *C. dacotense* and *S. venustum* (Figs. 10c, d and n) were related to peaks in light intensity of over 1600 units which occurred from 7-10 a.m. and from 5-6 p.m. Similar relations were found between the hourly emergence of other species and the major changes in light intensity.

Light has been shown to influence the emergence of other insects. Wishart (1946) in his study of the diurnal emergence of *Macrocentrus gifuensis* Ashm. (Hymenoptera, Braconidae), a parasite of the European corn borer, found that the early light of morning initiated emergence. The emergence could be retarded but not eliminated by keeping the pupae in the dark. He found, also, that the movement of those first emerging stimulated others to emerge if the pupae were close together. Sprules (1947) suggested that the diurnal emergence of aquatic insects was related to changes in light intensity.

SUMMARY

Collections of eleven species of black flies that emerged into a screen cage placed over a square yard of Costello creek were analysed for the years 1938-1947. The extreme span of emergence of all species for all the years extended from May 6 to September 7. Before 1944 most of the emergence took place in May and early June; after 1944, however, most occurred in June and July, partly because early species were absent or in low numbers and partly because the species present emerged later in the season. This change may have been the result of the application of D.D.T. to Costello creek in July, 1944. After 1944 the early species with only one annual generation required more years to re-establish themselves than those with more than one generation annually.

In all species the number of emergent flies fluctuated from year to year and this fluctuation was greater in some than in others. *S. venustum* varied from 3-72% of the total number in different years, being at least 14% in all but three years, whereas *P. hirtipes* varied from less than 0.1% to 88%. *S. euryadminiculum* and *C. dacotense* made up more than 60% of the collection in 1939 and 1942 respectively, but several species never comprised as much as 1% of the collections. The great increase in the emergence of *S. vittatum* and *S. decorum* after 1944 may have been related to the decrease in numbers of *P. hirtipes* and *C. dacotense*. The following species are arranged according to size of total emergent population, beginning with the most abundant: *S. venustum*, *S. vittatum*, *S. decorum*, *P. hirtipes*, *C. dacotense*, *S. tuberosum*, *S. euryadminiculum*, *S. aureum*, *S. costatum*, *C. mutatum* and *C. subexcisum*.

It appears that in biting species, except for *S. decorum*, the females are slightly predominant in number, whereas in the commonest non-

biting species the males are more numerous. A notable exception is *C. mutatum* with an exceedingly high proportion of females.

The emergence of *P. hirtipes*, *C. mutatum* and *S. euryadminiculum* is usually completed in May. The remaining species, with those having the earliest midpoint preceding, are as follows: *C. dacotense*, *S. costatum*, *C. subexcisum*, *S. aureum*, *S. venustum*, *S. tuberosum*, *S. vittatum* and *S. decorum*. The midpoints of these species vary from early June to early July. In a single species the time of emergence may vary a week or more depending on environmental conditions; for example, in *S. venustum* the midpoint varied from the end of May to early July in different years. In most species the average midpoint was a day or two earlier in the males than in the females.

There are two groups of black flies, those which have one annual generation, all of whose eggs enter a diapause, i.e. *P. hirtipes*, *C. mutatum*, *C. dacotense*, *S. euryadminiculum* and possibly *C. subexcisum*, and the other species studied which have two or possibly three generations annually, only some of whose eggs enter a diapause, although the generations were not always distinctly separated. However, in the latter group, because of immigrant flies, there may appear to be more generations in some years. Whether the species studied had one yearly generation or more, the period of emergence per generation averaged two weeks.

S. venustum was represented by two distinct populations in Costello creek in 1947 the "native" and "immigrant" populations, the former produced from overwintering eggs and the latter introduced during the current year by ovipositing females which presumably had immigrated to Costello creek from streams that had higher temperatures in the early season. Each of these populations had two generations, the females of the second generation laying eggs, most of which appeared to enter a diapause until the following spring. In 1946 only the "native" population, with two generations, was distinct although eggs of immigrant females may have augmented the total population. The distinctness of the "immigrant" generation will depend on the time of oviposition of immigrant females. An "immigrant" population was not as distinct in other species, although immigrant females of *P. hirtipes*, *C. mutatum* and *S. vittatum* were seen ovipositing in Costello creek.

The size of each generation will depend, among other things, on the temperature and water level throughout the season, and also on the predators in the aquatic environment. In addition, the factors affecting adult flies, mainly females, may have an important bearing on the size and time of each generation. Owing to the relatively dry condition during June and July in 1946 contrasted with that in 1947, many flies appeared to die a few days after emergence so that only a few came back

to oviposit. Little emergence occurred after the middle of July in 1946 but in 1947 a large emergence continued well into August and many more flies were seen ovipositing. This may have been affected also by a larger number of immigrant flies.

The rapid decline of emergence in mid-July, 1946 and in early August, 1947 may have been the result of several factors: (1) the temperature of the water rose above 80°F., (2) the level of the water decreased, resulting in a desiccation of eggs and pupae, (3) most of eggs of the second generation of *S. venustum*, the commonest species, appeared to enter a diapause lasting until the following spring, and (4) predacious hydropsychid larvae may have preyed heavily on the aquatic stages of the black fly because caddisfly larvae were plentiful in early August, 1947.

Most of the emergence in all species took place during the day with the midpoint, the time when half had emerged, at approximately noon. *C. dacotense* showed the longest period for 90% of emergence, the emergence being more uniform over this period than for other species. This may be related to its short, sharp, seasonal emergence. Emergence in all species appeared to be initiated by daylight, as it began before the water temperature started to rise, and peaks of emergence were related to increases in light intensity. Fluctuations in temperature, however, did exert some control on the hourly emergence.

ACKNOWLEDGEMENTS

Grateful acknowledgement is made to Professor F. P. Ide, Department of Zoology, University of Toronto, under whose direction this work was conducted. I wish to thank Dr. A. M. Fallis, Director, Department of Parasitology, Ontario Research Foundation, for his counsel and assistance. I am indebted to Dr. H. B. Speakman, Director, Ontario Research Foundation, for providing facilities for the research and for his interest and encouragement. I am grateful, also, to Professor R. R. Langford, Ontario Fisheries Research Laboratory, for providing accommodation during the summer. I am appreciative of the assistance of Mrs. M. Barlow in the preparation of the figures. I wish to thank Dr. Alan Stone, Bureau of Entomology and Plant Quarantine, Washington, D.C. who confirmed my identifications of the black flies.

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SOME FURTHER ADDITIONS TO THE BIBLIOGRAPHY OF CANADIAN PLANT GEOGRAPHY

J. ADAMS*

Ottawa, Ontario

These additions cover only the period with which my name has been associated, that is, up to the end of the year 1935. When the first part of the bibliography was published in 1928 I stated that in order to ensure correctness of each item quoted it would be necessary to have access to and handle each of the works referred to. For a variety of reasons this was not possible. In consequence minor errors were liable to occur in reference to the correct citation of the title, or the volume number, or pages, or the date of publication. But still it was possible for a person really interested to find the particular magazine or other publication which he wished to consult. After all a person who blazes a trail through a forest can hardly be expected to construct a macadamized highway. Many of these minor errors were corrected in the later parts of the bibliography but doubtless others remain. One error that has never been corrected is item No. 39 in the first part published, namely,

BROWN, R. General View of the Botany of the vicinity of Swan River, 1830. Jour. Geol. Soc. vol. 1, pp. 17-20, 1832.

As Robert Brown had published a series of papers dealing with the Flora of Arctic Canada I naturally assumed that the locality referred to was the Swan River in Manitoba. But some years ago Mr. John Ardagh of the Department of Botany, British Museum, London, whom I had known previously when he was connected with the National Museum in Dublin, very kindly called my attention to the fact that it was the Swan River in Western Australia that Robert Brown had in mind and not the river of the same name in Manitoba. Hence this item should be deleted.

After the publication in 1932 of the section dealing with the period 1926-1930 I decided to include papers referring to Greenland, as having more affinity with North America than with Europe in order to make the bibliography more complete. Accordingly, although it was more difficult to obtain access to papers dealing with the Greenland flora, a list of 197 papers was published in the next section issued in 1936. Knowing that the opinion of Dr. Morten P. Porsild of the Danish Arctic Station at Disco, Greenland, would be valuable in connection with this matter I sent him a copy and received the following reply dated August 16, 1937:

*We regret that news of Mr. Adam's death was received recently.

Dear Sir

A complete bibliography on the botany of Greenland will be a rather tough job for which I shall have no time, at least at present. But as the general bibliography on Greenland, in Meddelelser om Grl. XIII, badly needs revision of the period before 1880, and enormous additions for the subsequent period, I think a new and complete bibliography, made by experts, is contemplated, as soon as the necessary funds become available.

Very truly yours
MORTEN P. PORSILD

The list referred to by Dr. Porsild is evidently No. 91 in the Greenland section, namely, LAURIDSEN, P.- -Bibliographia Groenlandica, Medd. om Gronland, vol. 13, pp. 1-247, 1890, but whether anyone followed up the suggestion I do not know, but it is probable that after the outbreak of the Second World War nothing further was done.

The present list of additions comprises thirty-five titles of which five relate to Greenland. The method of citation employed follows that used in the previous sections of the bibliography. (See Trans. Roy. Can. Inst. Vols. 16, 17, 18, 21, 26.)

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ORR LAKE POTTERY

A STUDY OF THE CERAMICS OF AN EARLY HISTORIC HURON SITE

KENNETH E. KIDD

Deputy Keeper, Royal Ontario Museum of Archaeology

A. INTRODUCTION

1. *The Mutrie-McGuire Collection.* This paper is an attempt to describe a collection of early historic Huron Indian pottery, presented in 1946 to the Royal Ontario Museum of Archaeology by Mr. D. M. McGuire and Mr. J. Fred Mutrie. The site from which Messrs. McGuire and Mutrie collected the material is situated on lots 68 and 69, Old Survey, Township of Flos, Simcoe County, Ontario, about one-quarter of a mile north of a small body of water known as Orr Lake. The land at this spot is fairly level, slightly higher than the lake itself and slopes gently toward the southeast. Unlike most locations chosen by the historic Huron, this site was not situated on a headland, and therefore was not easily defensible—a fact which suggests, though it does not prove, that its occupation may date from the very early contact period, possibly around 1610 or 1615 A.D. The site covers perhaps ten acres of light sandy loam.

The pottery was recovered from three large refuse mounds scattered irregularly over the area. Much other material, such as clay pipes, stone pipes, bone tools, chert artifacts, some shell goods, and European glass beads and metallic objects, was found with the pottery, but is not described here. No stratification is reported, though some of the ceramic ware is sufficiently different from the rest to indicate seriation if not stratification. The aberrant pottery (which is small in quantity) is identical with that which is obtainable at certain prehistoric Huron sites in the immediate neighbourhood. Reference will be made to this again in the following pages.

The collection presented to the Museum and analysed in this paper comprises perhaps one-tenth of the total number of sherds collected at Orr Lake. It amounts to approximately 1700 sherds, which is probably a fair sample and enough to give statistically valid results. Moreover it is considered to be representative of the collection as a whole as regards shapes, sizes, techniques and decorative styles. On these criteria, it has been examined from the descriptive and statistical viewpoints, and certain comparisons instituted with material from other Iroquoian sites in the province.

2. *Raw Materials.* No effort has yet been made to determine the origin of clays used by the Indians of this or of any other Huron site for ceramics. There is every reason to suppose, however, that they obtained

their supplies locally, and if such is the case, it is easy to understand how the finished product would vary according to the source. Almost every local stream cut shows faces from which serviceable clays could be gathered. These are either shale or surface clays, of Ordovician or glacial origin and burn to a red.[1] Around Lake Ontario and in the Huron country, these clays often show a high lime content which renders them risky for use in making tile or brick. Stratified glacial clays occur in small pockets here and there, as at Minesing, about twelve miles southwest of Orr Lake, where they are used at present to make a cream coloured brick and tile.[2] The Orr Lake Indians may have utilized any of these local deposits, either of glacial or of earlier origin, and the results would be much the same.

Crushed granite containing spicules of mica is the common tempering ingredient. The grains vary widely in size. In some vessels from Orr Lake, the proportion of tempering material to clay is high, yet in pipes is almost entirely lacking.

3. *Construction of Vessels.* Vessels are built up by the paddle and anvil method, as may be seen from the laminated structure of almost any sherd. There is a strong tendency to fracture along this line of lamination. In a few cases, it appears that additional pats of clay have been added to the already moulded surface, especially in much-thickened collars. The majority of Orr Lake sherds are thin, averaging about three-sixteenths of an inch, though this of course varies somewhat in hand-made ware. The aberrant pottery from this site shows a greater thickness, often of about one-half inch, with heavy castellations which may be an inch thick in places. Such wares have a bold, deft decoration which, while it is still in the Huron tradition, suggests a somewhat earlier origin than the majority of the vessels from the site. Correlations between thickness and decorative styles are shown in Table I.

4. *Firing Methods.* No potteries have been found, which may indicate that firing was done where and when need arose and not in any one appointed place. It is probable that unbaked vessels were laid on the bottom of a hearth and piled round with firewood arranged in a conical fashion over them, not unlike the method used by modern Mayan peoples.

The fire, whatever its construction, attained a temperature approaching 900° or 1000° F, as determined by Mr. A. P. Birks of Toronto. Mr. Birks placed Orr Lake sherds in his electric kiln and observed no change until the above temperature was exceeded; at 1500° F, the colour deepened to a bright red and slight fusing occurred. During the native firing, the clays baked to a dull, dark grey or a dull grey-red.

[1]Montgomery, 1930, p. 33.
[2]Montgomery, 1930, p. 154.

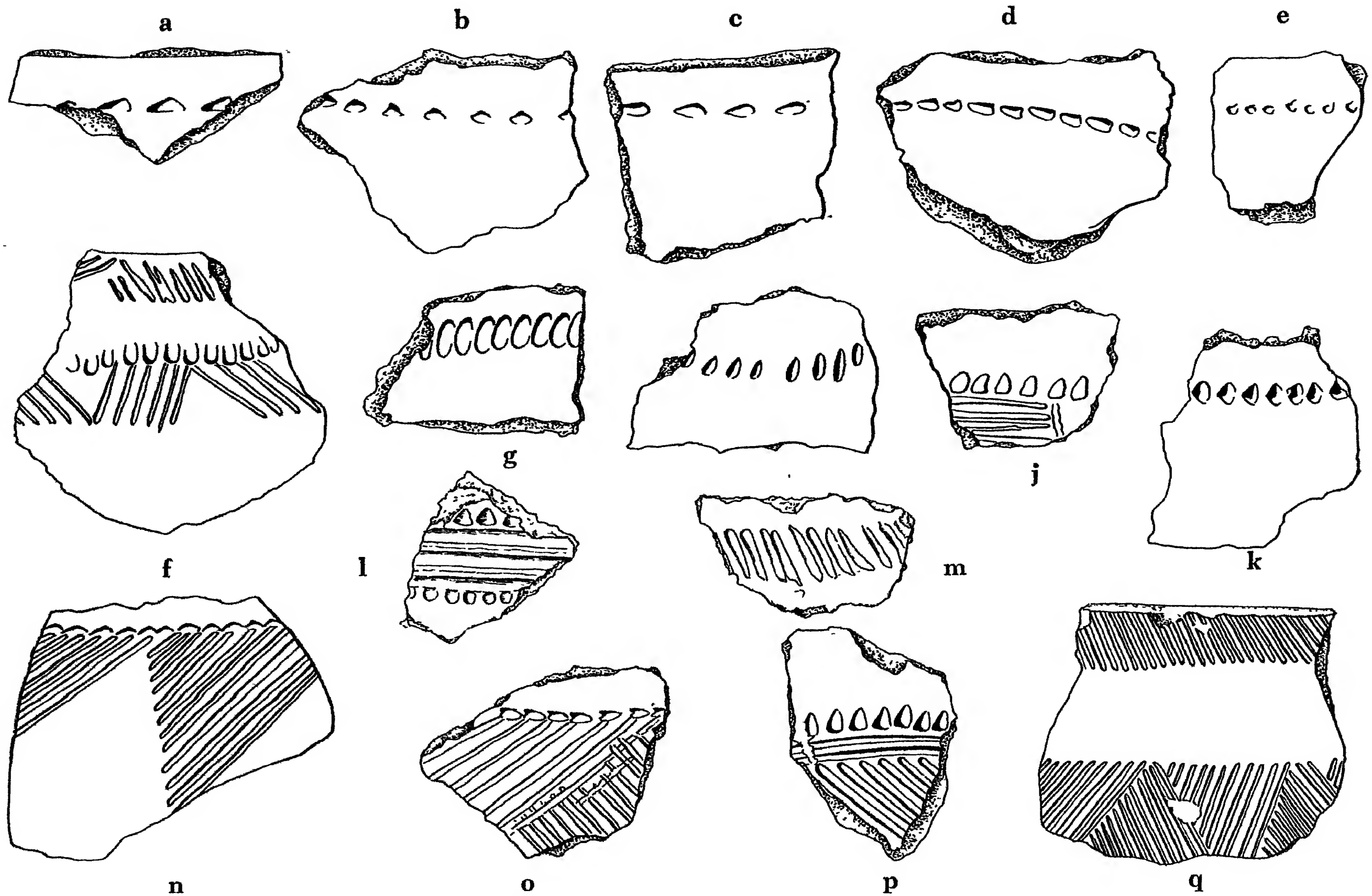

FIG. 1.—Shoulder Sherds. Decorative styles illustrated are as follows: a, 1; b, 3; c, 4; d, 5; e, 6; f, 21; g, 9; h, 11; j, 29; k, 7; l, 25; m, 10; n, 16; o, 20; p, 23; q, 15.

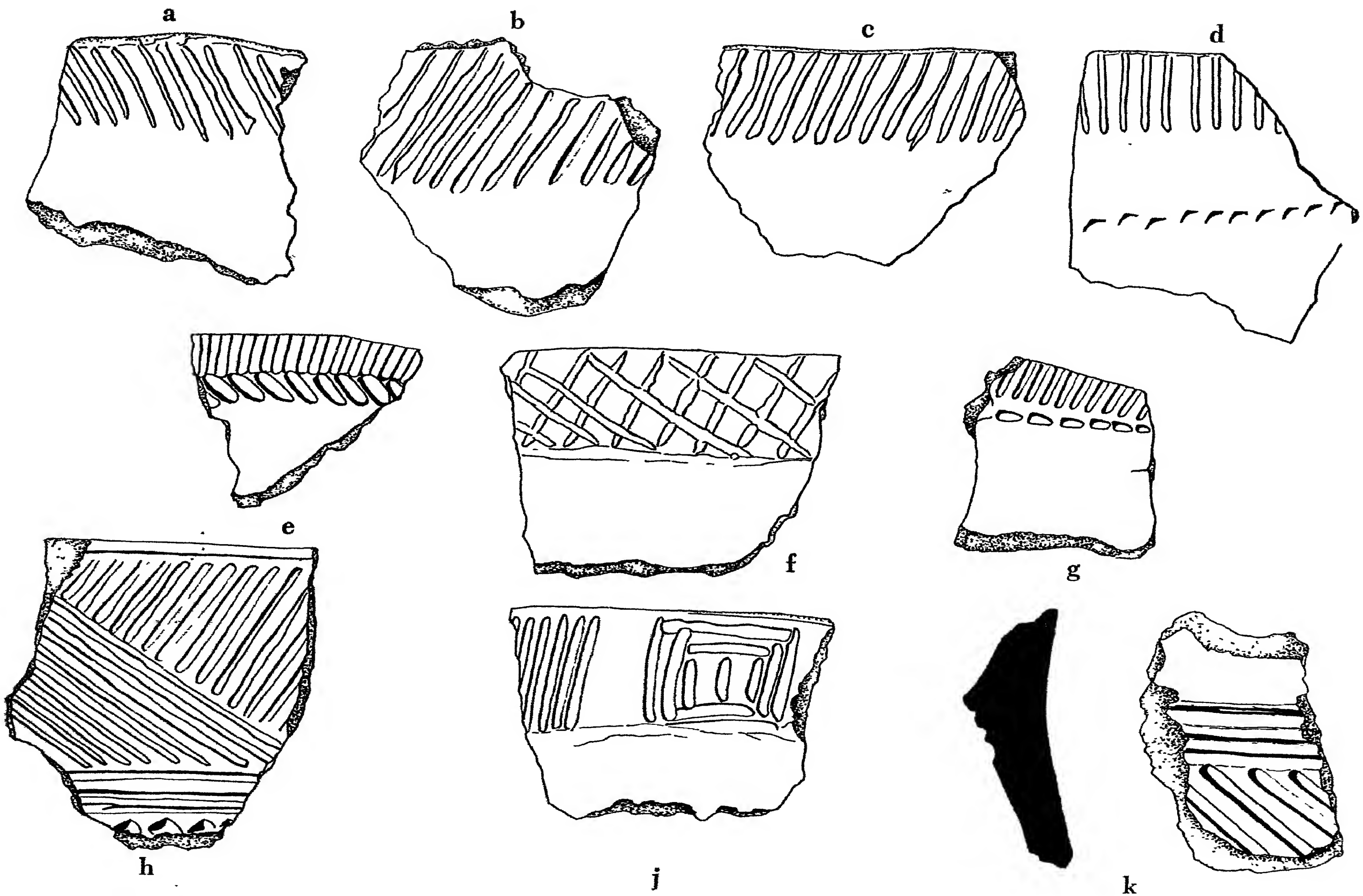

FIG. 2.—Rim Sherds. Decorative styles illustrated are as follows: a, 36; b, 37; c, 37; d, 38, e, 40; f, 39; g, 61; h, 48; j, 50; k, 45.

TABLE I

TO SHOW THE THICKNESS OF VESSEL WALLS IN MILLIMETERS, AND THE CORRELATION BETWEEN THICKNESS AND DECORATIVE STYLE

Thickness in mms.	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	25	
Style group 1	7	21	36	50	50	47	41	20	6	6	7	2	2	2							297
Style group 2	1					3	2	4	2	2		2	1	1		1	2	1	1	1	24
Totals	8	21	36	50	50	50	43	24	8	8	7	4	3	3		1	2	1	1	1	321

Style group 1 includes styles 36, 37, 38, 39, 40, 48
Style group 2 includes styles 41-47, 49, 56, 57, 58, 60-65.

5. *Artistry.* The making of pottery was handled by the Orr Lake Huron with considerable skill and assurance, though with less of both and certainly with less artistry than by the prehistoric people who immediately preceded them and produced the thicker, harder and more boldly ornamented ware which has already been referred to as "aberrant". One gets the impression that the makers were competent potters, but that they had ceased to be inspired by their craft.

6. *Shape.* Our study is largely restricted to neck and collar shapes, since the majority of sherds bearing significant form and design belong to those regions. Body sherds, all showing a fairly uniform curvature, indicate that the bottoms of vessels were rounded in the usual Huron fashion. Body shapes were evidently globular or depressed globular. In a few instances there is a pronounced collar. An exceptional shape, probably not known from non-Huron sites, is one in which the vessel has an elliptical outline with a pronounced shoulder, so that at least one end, and probably at both, there is a sharp, vertical ridge.

Necks are short and of only slightly less diameter than the vessel. Narrowly restricted necks are never found.

The rim, or element above the neck, may be vertical, curved inwards, or curved outwards. It may have no collar or thickening below the lip or it may have an incipient collar or even a well-developed one. Taking the entire collection of rim sherds, slightly less than one-half are of the first class, slightly more than one-half are of the second, and only one and one-half percent fall in the last category. This is significant, for well-developed, overhanging collars are usually considered characteristic of late Iroquoian wares. Cross-sections of rims, showing the collar form, may be seen in Figs. 2, j and 3, j. Lips, or the uppermost part of the rim, may be (a) square, i.e. flat on top with edges forming right angles; (b) rounded; (c) oblique toward the outside, i.e. flat but slanting outwards and upwards; (d) oblique towards the inside (the reverse of *c*); and (e), pointed. The first class includes nearly half of all lips in the entire collection; the second class, thirty-seven percent, with small percentages in each of the other three classes.

7. *Diameters.* An analysis of 307 measurable rim sherds shows that dimensions across the rims range from two to eleven inches (Table II). Since the rims are nearly always of less diameter than the bodies, these figures have a restricted significance. But the vessels are not large, on the whole; sixty-six show a rim diameter of three inches; eighty-nine of four inches; fifty-six of five inches; and thirty-nine of six inches. Only two vessels have a rim diameter of ten inches and twelve of eleven inches. The large five gallon vessels known from other Iroquoian sites are absent. Estimates of the heights of vessels could not be ascertained due to the fragmentary nature of most of the sherds. Complete outlines were likewise unobtainable.

8. *Exterior Treatment.* Surface treatment may be either plain, modelled or decorated with incising, and punctating. The present collection contains 937 plain sherds of all kinds, out of a total of 1735, in addition to 715 decorated sherds and ninety-four which are modelled.

Exterior surfaces were probably scraped with some instrument to make them relatively smooth, then rubbed by hand to obliterate any harsh lines which might be left. The rubbing had also the effect of "floating" the ware, that is, of bringing to the surface the fine particles in the material which leave a characteristically smooth surface. This was then followed, in most cases, by further treatment such as texturing, incising, or punctating. As may be seen in Table III, ninety-two percent of all body sherds are plain, in contradistinction to shoulder sherds of which ninety-five percent are decorated, and to neck, rim and castellation sherds.

TABLE II

TO SHOW THE DIAMETERS OF VESSELS IN INCHES, AS MEASURED ACROSS THE RIM, AND CLASSIFIED ACCORDING AS THE SHERDS ARE PLAIN OR DECORATED

Diameter in inches	2	3	4	5	6	7	8	9	10	11	Totals
Plain sherds	9	58	82	49	35	10	5	12	2	8	270
Decorated sherds	3	8	7	7	4	2		2		4	37
Totals	12	66	89	56	39	12	5	14	2	12	307

Rims, necks, shoulders and castellations are decorated with incised and punctate designs or both. The incised work takes the form of hatching almost exclusively; punctation may stand either by itself or be used in combination with incising. Hatching is commoner on the rim than on the shoulder, but may occur on either, while punctation is commoner on shoulders where it may be the only attempt at decoration.

(The term "incising" is here used somewhat freely to denote two techniques. In the first sense, it implies true incising, in which a sharp tool has been drawn through or over the plastic material to leave a channel, usually with rough, elevated edges (ninety percent of the total) (Fig. 2, b). In the second sense, it is used to denote a form of decoration done evidently with a flat, toothed instrument, which on being drawn over the surface of the vessel, leaves one or more "incised" lines which however lack the rough edges (Fig. 1, n, q.). The first type is found more frequently on the thin ware; the latter on the apparently earlier "aberrant" ware. Figs. 2g, k; 3e, f, h; 4l).

Twenty body sherds, otherwise plain, bore indeterminate markings which could be interpreted as painting. These possible paint marks are

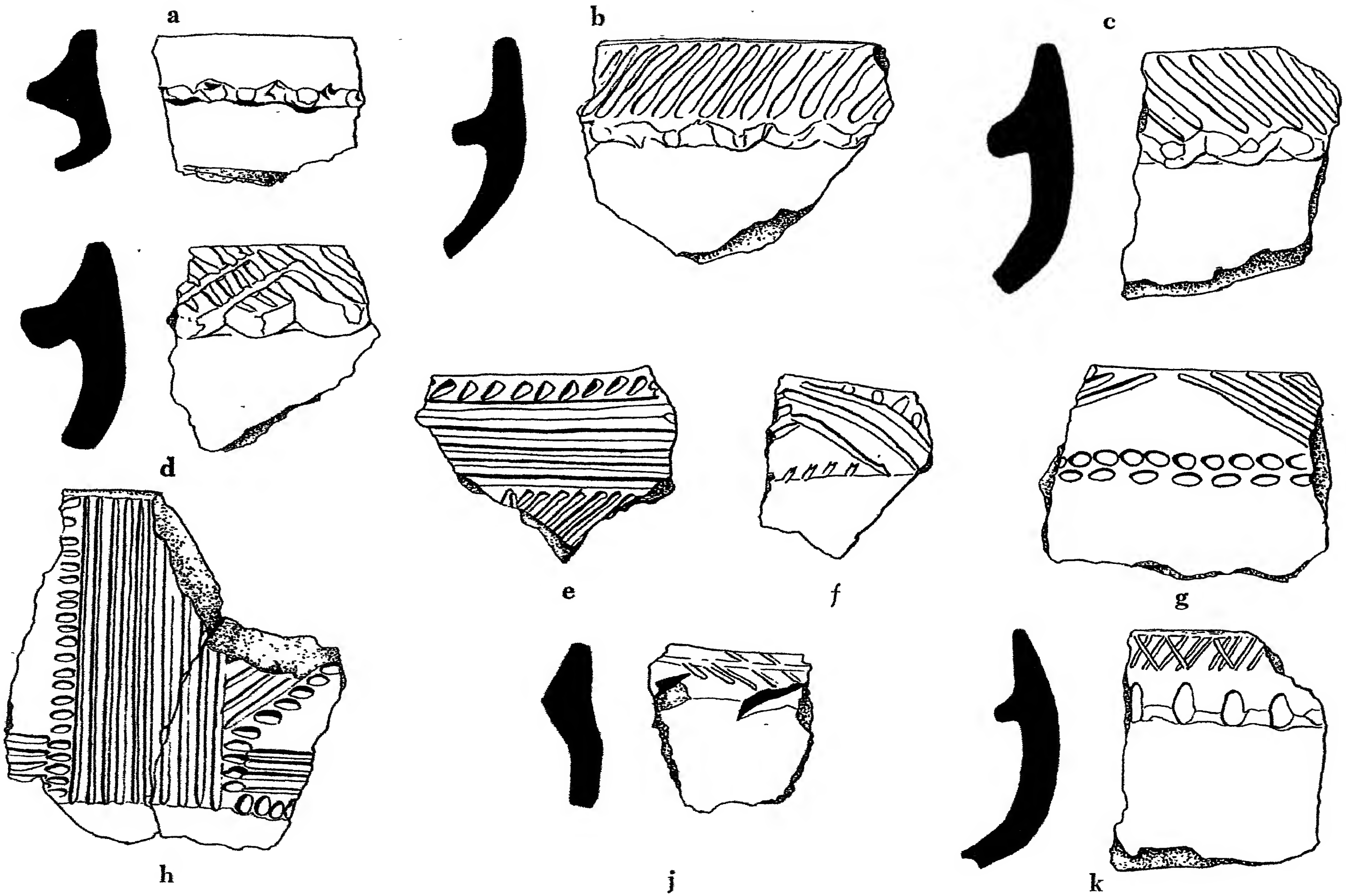

FIG. 3.—Rim Sherds. Decorative styles illustrated are as follows: a, 52; b, 53; c, 54; d, 55; e, 56; f, 65; g, 64; h, 62; j, 59; k, 55.

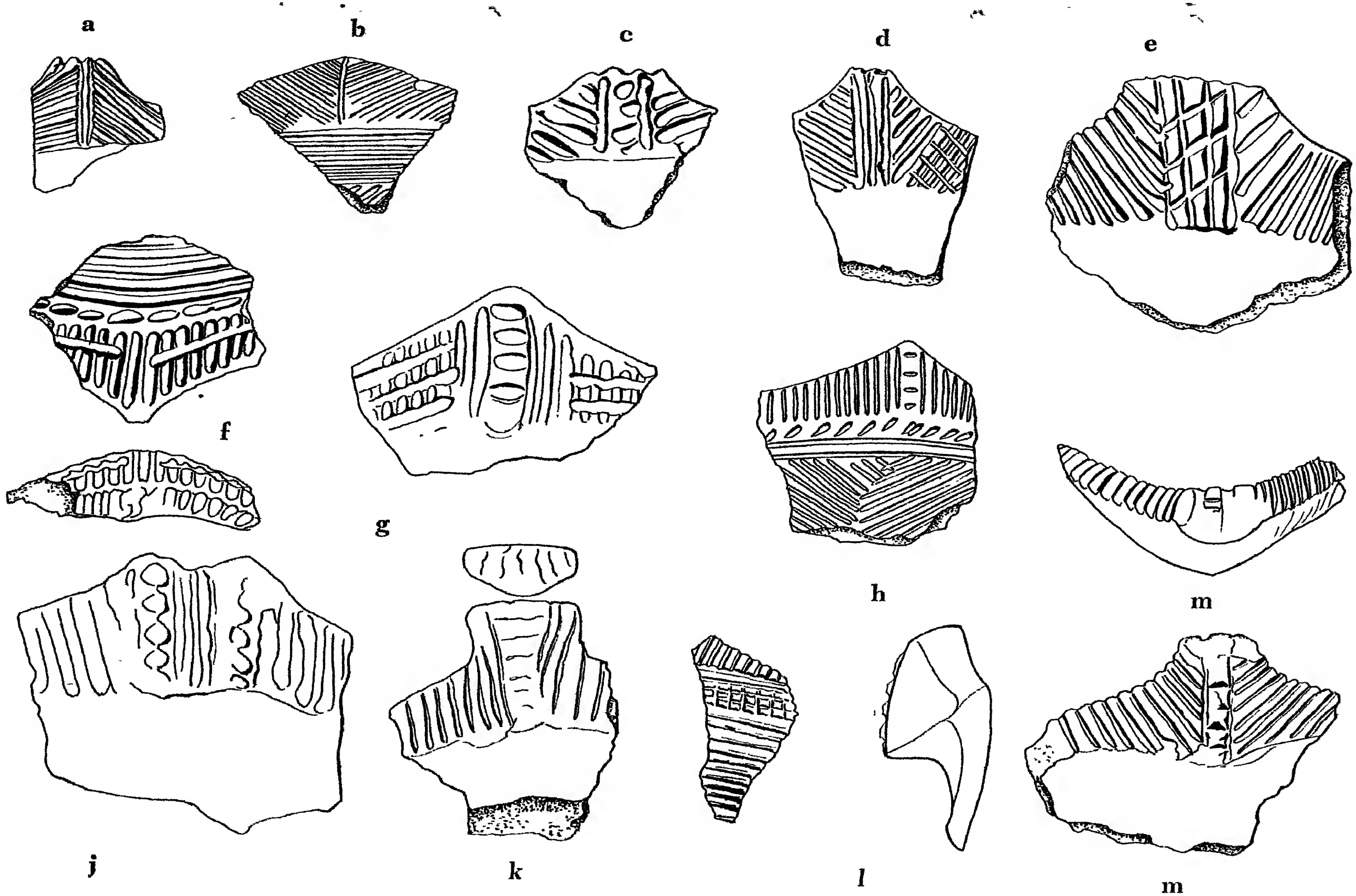

FIG. 4.—Castellation sherds. Decorative styles illustrated are as follows: a, 69; b, 66; c, 73; d, 70; e, 79; f, 81; g, 84; h, 80; j, 86; k, 83; l, 60; m, 75.

irregular and without pattern, but show up as heavy, solid black splotches on the otherwise grey background. Examination under the ultraviolet light showed that they are not recent marks, but of course did not indicate their composition, which could only be done by chemical analysis.

On ninety-four sherds the collar is thickened somewhat at the lower portion and notched, more or less in pie-crust fashion. The individual notching varies a good deal, from large and heavy to small and fine, and there is considerable variation also in depth, spacing and shape. (Figs. 3a-d, j, k).

Castellations in general are simple in form and modest in size. (Fig. 4, a-m). They are never excessively overhanging. No estimate of the number on a single rim was possible in this collection since no complete rims were found; probably from one to four would be the range, with the lower numbers predominating. Castellations are marked by a somewhat

TABLE III

TO SHOW THE OCCURRENCE OF PLAIN, TEXTURED, DECORATED AND PAINTED SHERDS, WITH PERCENTAGES OF EACH

	Body		Shoulder		Neck		Rim		Castellation		Totals
	No.	%	No.	%	No.	%	No.	%	No.	%	
Plain	875	92	34	4.5	6	19.4	20.	13.8	2	3.1	937
Textured	63	6									63
Decorated			211	95.5	25	80.6	430	86.2	58	96.6	724
Painted	20	2									20
Totals	958	100	245	100	31	100	450	100	60	100	1744

Duplicates—9.

greater thickness than the rest of the rim, a more or less pronounced concavity on the inside and a corresponding convexity on the outside, either with or without a projecting prominence. All have one or more peaks or elevations on the rim; in forty-eight sherds the peak is pronounced, in the remainder it is either broad and short, or rounded. The peak itself is usually ridged crosswise with from one to four grooves. One castellation shows two small peaks, both somewhat rounded (Fig. 4j).

Evidence of a handle was found only on one sherd. The lug drops from the lowest point of the collar to the nearest point on the neck and is not over one inch long.

9. *Interior Treatment.* Interiors, like the exteriors, were scraped with some flat object but, unlike the latter, were usually left in that condition without additional smoothing. Sometimes they were appar-

ently scarified with a wisp of grass and occasionally bolder striations occur.

Decorative treatment on the inside was found on four sherds only. This is always on the inside of the rim about one-half inch below the lip, and consists of a simple band either in style 36, 37 or 38 (see list of styles). The percentage of interior decoration is obviously negligible, but its presence is noteworthy.

B. DECORATIVE TREATMENT

1. *Body Sherds.* Out of a total of 958 body sherds, 875 are plain (ninety-one percent); sixty-three have some form of textured surface (six percent) and the remaining twenty bear the so-called paint marks, but are otherwise plain surfaced.

Texturing, when it occurs on the body, is usually vague and indeterminate in character, as if it had been done with an instrument and subsequently partially obliterated by smoothing. A paddle, faintly grooved in something like a waffle pattern, would leave such impressions. The commonest form consists of interrupted, usually horizontal striations of varying degrees of coarseness; twenty-eight sherds or forty-four percent of all textured body sherds possess widely-spaced, long, broad, and shallow rectangular markings of this sort; nine sherds or fourteen percent bear short, wavy impressions; one, a fine-textured pattern consisting of small, broken-line impressions arranged more or less in parallel lines; twenty-five sherds possess short, wavy-line impressions arranged without order.

Texturing is not a common characteristic of Orr Lake pottery, being found on six percent of the total and then only on body sherds.

No body sherds in the collection have any decoration of an incised or punctate nature.

2. *Shoulder Sherds.* The number of decorated shoulder sherds is 211, or ninety-six per cent of the total.

There are twenty-five styles of decoration (styles 1-25). As on the necks and rims, both incised and punctate styles occur, but the latter greatly predominate. Only two styles are limited to incising, and one of these consists of hatched triangles, the hatching in alternate triangles running in opposite directions (Fig. 1q). Nine styles combine incising and punctation; in six of which hatched triangles, usually with no alternation of direction, are surmounted by a band of some form of punctation, the remainder showing horizontal incising bordered with punctation (Fig. 1, f, j, l, n-p). The nine other styles use punctation only. Styles in which punctations only occur are more abundantly represented than complex ones, accounting for 149 or seventy percent of all decorated sherds. A common style is that in which a single band of

punctation encircles the vessel near the edge of the shoulders. The decoration may be bold or it may be fine; but usually it gives the impression of a sort of stitching effect (Fig. 1a-e, h, k).

Punctations may be triangular, in which case the depressions vary in depth from side to side, giving quite different effects; lenticular, round, or oblong. A rare style is almost crescentic in form. Sizes vary from small to one-quarter inch or more in length.

3. *Neck Sherds.* In some cases, it is possible to determine from the curvature that the sherd was from the neck, while other sherds are large enough to show the styles of decoration employed on both rim and neck, or on neck and shoulder. The total number of neck sherds is still small, however, totalling only thirty-one.

Out of this small number, ten different decorative styles may be isolated, while fourteen of the sherds are entirely plain. One of the styles (#26), is also present on rim sherds. Horizontally incised lines, either singly or grouped to form a band constitute a popular motif and are sometimes combined with punctation or hatching. Hatching is present in nine styles; punctation in eight; but punctation alone in only one. In view of the small number of sherds representative of neck styles, it is possible only to say that both incised and punctate designs are employed on that element, and that the latter is seldom used alone.

4. *Rim Sherds.* The total number of rim sherds is 450, enough to allow some inferences concerning styles employed thereon.

As on the neck, incising and punctation are the only two methods of decoration. The former may be employed singly or in combination with punctation, but usually singly. Punctation does not exist alone. Incising is of four main basic forms consisting of (a) vertical hatching (Fig. 2d), (b) hatching toward the right or dextral hatching (Fig. 2a); (c) hatching toward the left or sinistral hatching (Fig. 2b-c) and (d) horizontal lines (Fig. 3e). All of these exist, apparently, as separate or sole motifs except (d). Indeed, decorative styles comprising the elemental forms (a), (b) and (c) account for the three largest single groups for under (a), style 38 is present on forty-one sherds; under (b), style 36 on thirty-three, and under (c) style 37 on 161, which is the largest single group in the entire collection.

Combinations of these elements rank next in importance, such as cross-hatching (combinations of (a) and (b)) (Fig. 2f); or arrangements of triangles in which the direction of the hatching in one is at right angles to that in adjacent ones (Fig. 2h); arrangements of triangles in which alternate triangles are hatched and the intervening ones left plain (the hatching in such cases being usually one-directional) (Fig. 3g), and chevrons.

Incised designs, either in the form of hatching or of horizontal lines

may be combined with some form of punctation. Thus, in addition to simple incised horizontal lines bordered top and bottom with punctations of some form (style 27), there are styles wherein hatched triangles and plats are likewise treated (Fig. 3h). The latter combination gives rise to the greatest variety of styles found on this ware, including such complex patterns as triangles hatched in alternate directions, with the intervening triangles left plain, except for a border along one or two sides of punctations (e.g. styles 47, 63, 64).

While a few vessels with notched rims are devoid of any other form of decoration, most of them are incised, most commonly in style 53 (sinistral hatching, or in style 54 (widely spaced dextral hatching) (Fig. 3b,d). A small number of rim sherds is also entirely plain.

The total number of decorated rim sherds is 430, or eighty-six percent of the total. Since ninety-five percent of the shoulder sherds bear decoration, the feature is commoner on shoulders by about nine percent. Thirty styles are represented.

5. *Castellated Sherds.* The collection contains sixty sherds with castellations, two of which are entirely plain, the remainder decorated in a total of twenty-five styles. The styles are, like those on the rims, all rectilinear, and consist either of incised hatching alone, or of incised hatching combined with punctation. The simplest form is continuous with that on either side (four sherds). There are two and three sherds respectively bearing dextral and sinistral hatching only, (Fig. 4a, b); one bears vertical hatching with a horizontal groove drawn through the centre of the band on either side (Fig. 4f). The commonest generalised style is that in which there is a band of varying width below the peak of the castellation, and in which may occur either (a) vertical hatching (Fig. 4a, b, d), (b) cross hatching (Fig. 4e), or (c) one or two vertical rows of punctations (Fig. 4c), the band bordered at the sides with hatching in opposite directions. Most of the styles are represented by single sherds, except as noted above.

Castellation decoration is characterised by the same basic incised hatching as the rim, with the addition of a rather simple vertical band in the centre which usually bears punctations or cross hatching.

6. *Lip Sherds.* The top of the rim, or lip, where a flat surface is presented, is decorated in thirty-nine sherds, with a total of eighteen styles. These are either incised or punctate (Fig. 4f, m top). In general, the hatching may run in either direction and may vary greatly in width, depth and degree of care with which it is done. Punctations are commonest, occurring in twenty-five sherds or fifty-nine percent; shapes are oval, broad triangular, obtuse-angled triangular with the long side concave (style 1), lenticular or round. One interesting

specimen has two rows of small punctations with a notched rim. Broadly speaking, decoration on the lip seems coarser than on other elements.

7. *Correlations.* Correlations between collar and lip shapes have been worked out on a percentage basis, and while the number of useful sherds was sometimes smaller than desirable, the results may be worthy of examination. (Table IV). For this purpose, only the six styles having the largest number of sherds were used. Notched rims were excluded.

TABLE IV

TO SHOW CORRELATIONS BETWEEN COLLAR AND LIP SHAPES, AND THE PRINCIPAL DECORATIVE STYLES FOUND THEREON, EXPRESSED IN PERCENTAGES

Style No.		36	37	38	39	40	48
Number of sherds		13	161	41	28	8	17
Collar	a	53	25	64	32	62	18
	b	47	70	35	64	38	82
	c		5	1	4		
Lip	a	47	54	53	32	38	55
	b	53	30	32	57	25	22
	c		2	2	4		
	d		14	13	7	25	11
	e					12	11

Note—The following legend is employed in the above table:

Collar a — indicates *no collar.*
b — " *incipient collar*
c — " *well-developed collar*
Lip a — " *square lip*
b — " *rounded lip*
c — " *lip oblique toward the outside*
d — " *lip oblique toward the inside*
e — " *pointed lip*

In style 36 (dextral hatching), rims without a collar or with an incipient collar only are commonest; there are in fact no other shapes, and between these two, there is little difference in frequency. In styles 38 and 40, rims without collars are nearly twice as abundant as those with incipient collars, and only in the case of the first is even a well-developed collar present. In strong contrast to this is the fact that in styles 37, 39 and 48 the number of incipient collars is from two to three times as great as the collarless form; and two of these, styles 37 and 39, both have a small number of sherds with well-developed collars. Stylistically, therefore, collarless and incipient-collared rims are about equal; numerically, however, rims with incipient collars are far ahead, with styles 37, 39 and

48 present on them, for there are nearly five times as many sherds represented in the last group as in the first. No overhanging collars are present in combination with any of the styles used above.

The styles selected for this analysis are fairly well distributed on sherds possessing the various types of lip form. Lips oblique toward the outside and pointed lips, however, are both sparsely represented, while the majority of sherds fall in the square or rounded lip class. The simplest form of lip—the square—is employed in conjunction with all six styles of decoration selected for the analysis (the same as above); in four instances, the majority of the sherds also are square, and in three more than fifty percent are so shaped. The rounded lip is next most frequent on all styles, but only in two does this form constitute a majority (styles 36 and 39). Lips which are oblique toward the outside make up the third largest group, and are used in combination with all of the selected types except one (#36). Finally, more than one-half of all sherds analysed had square lips and either vertical or sinistral hatching.

Table III shows the ratio of plain to decorated sherds in the various elements of a vessel. Thus, a higher percentage of castellated than of any other kind of sherd bears decoration, in this case ninety-six percent; shoulder sherds are next with ninety-five percent, then rim and neck sherds. Conversely, the fewest plain sherds are to be found among the castellations, and the greatest number among the body sherds.

If the data given in Table III are prepared in graphic form, it will become plain that style group 1 (which includes styles 36, 37, 39, 40 and 48), contains sherds which range predominantly between about five and twelve millimeters in thickness. On the other hand, style group 2, which includes styles 41-47, 49, 56, 57, 58 and 60-65, has a wide spread, from four to twenty-five millimeters in thickness. The latter group contains those styles which are considered typical of protohistoric Huron, here called "aberrant", while group 1 consists of styles typically historic Huron. In other words, the styles most common on the site and which seem to characterise historic Huron wares there, when compared with certain other sherds found on it, are consistently thin. The thicker sherds with the bolder designs of group 2 are relatively few in number.

Coming now to the size of vessels as a whole, an examination of Table II will reveal that there is a considerable spread in diameters. The smallest, which is two inches across the mouth, is represented by twelve examples which are measurable; and the largest, eleven inches, also by twelve examples. In between these limits, frequencies cluster towards the lower range.

C. SUMMARY AND COMPARISONS

Brief comparisons have been made between Orr Lake wares and those from other Iroquoian sites excavated in Ontario and with surface collec-

tions. Wintemberg's work[3] at the Uren, Lawson, Roebuck, Middleport and Sidey-Mackay sites has yielded the only important comparison, since the surface material is insufficiently documented to be of any use.

1. *Decoration.* Orr Lake and Uren wares have only two rim styles which are identical, no neck or shoulder styles in common and only three common styles in body texturing. Both possess rectilinear designs, trailed or incised and punctations, but Uren shows no hatched triangles. Shoulder decoration at Uren is lacking or meagre, though fairly common at Orr Lake. Body markings at both sites include paddling and scarifying, though individual markings seem to differ somewhat. Therefore, aside from some common techniques and a small number of similarities, the two wares have little in common.

Parallels with Roebuck are stronger. Rim decorative styles are directly comparable in six cases, with seven others possibly the same as far as can be determined from the illustrations. Except for the plain ware, there are no similar body decorations, and only two on the neck and three on the shoulders. For the most part, Roebuck styles are more complex than those at Orr Lake, and the use of the impressed circles, often arranged in triangles, is more common.

Strangely enough, similarities with Lawson material are even less numerous although superficially the two wares appear to have more in common than either has to Roebuck. Seven rim styles are possessed by both; at Lawson one of these is present on 350 rim sherds and another on 210, while all others occur on much smaller aggregations. This to some degree corrects the imbalance and ties Lawson more closely to Orr Lake, for the two styles which have the highest incidence at each site are common to both. Again, except for plain sherds, there is no stylistic agreement in body, neck or shoulder decoration. The presence of hatched triangles and the frequent combinations of hatched incising with borders of punctation on rim sherds at both locations is a striking feature. Besides, rolled collars are common to both. On the other hand, the curvilinear design found at Lawson is absent from Orr Lake, as are also all life forms.

Ten rim decorative styles, one body style and two shoulder styles are shared by Orr Lake and Middleport. As at Lawson, the two most abundant rim styles are also abundant at Orr Lake. In fact, they are a common bond between all three sites. At Middleport, styles incorporating a large incised V element are characteristic, as is the use of the circle, and a wide band of horizontally incised lines around the rim, none of which is found at Orr Lake.

Affinities undoubtedly exist between Orr Lake and the Sidey-Mackay

[3]Wintemberg, 1928, 1936, 1939, 1946, 1948.

site some twenty miles to the west of it. These affinities are general rather than specific, for the decorative styles of the two wares, though similar, seldom correspond exactly in detail. For instance, there are two precise parallels in shoulder design, nine in rim design and four in castellation design, but one might have expected more agreement between them in view of the apparent general similarity of treatment.

2. *Shape.* Uren vessels are more elongated than those from Orr Lake and shoulders less pronounced. Castellations are lacking and lip shapes appear more diversified. Collars are lacking or nearly so.

Body shapes at Roebuck and Orr Lake are probably in closer correspondence. The vessels differ radically, however, in the upper parts, for the heavy, overhanging collars and great castellations of Roebuck are almost unknown at Orr Lake, where overhang is moderate and collars much slighter. Moreover, lugs such as are found on some of the Roebuck wares are scarcely in evidence at all at Orr Lake.

Rolled collars and small castellations are common both to Orr Lake and Lawson. The latter, however, shows no flat lips, or notching, both of which are characteristic of Orr Lake material. Castellations are probably rarer at Lawson than at Orr Lake and collars less developed. Body shapes are evidently taller than those at Orr Lake, where they tend to more globular forms, and the cup-like shapes of Lawson are absent. On the other hand, collars are more pronounced at Orr Lake.

Middleport vessels are probably similar in shape to those from Orr Lake and possess rolled and vertical collars and moderate castellations. Overhanging collars are seemingly rather common at Middleport and notching is not used.

The absence of exaggerated body shapes and the presence of the elliptical form referred to above indicate a close connection between the Sidey-Mackay and Orr Lake sites. Rolled collars, the modest development of castellations and the cross-sections of rim sherds are other common denominators, though notching is rare at the former.

3. *Summary.* The Mutrie and McGuire collection of pottery gives a fair representation of the wares used by the Huron Indians at the Orr Lake historic site. While most of the pottery is relatively thin, grey to reddish in colour and has a moderately smooth surface, there is a small amount which differs from it in being much thicker, harder and possessing a carefully executed, bold design. This decoration is in strong contrast to that on the first type, which is rather carelessly done in true incising technique, whereas the latter is evidently done with a tool. The contrast between the two is so strong as to lead one to establish two principal wares at this site; and since the thinner, less carefully decorated type is not only more abundant here but at historic Huron sites elsewhere, it is concluded that it is Historic Huron, whereas the minority is found also

on prehistoric sites in the Huron territory, and therefore judged to be of Prehistoric Huron origin.

Orr Lake pottery has its nearest affinities with Lawson and Middleport. This similarity does not extend to the point where Orr Lake pottery can be matched sherd for sherd from either of these sites, but it does mean that the five or six styles most common at the one are also the commonest at the other two, thus establishing a strong linkage of shared traits. Uren is least like Orr Lake of all the sites studied, and Roebuck is intermediate. However, no curvilinear or circle designs occur at Orr Lake; the preponderant techniques are incising and punctating. In shape, size and decorative treatment and collar and castellation form, Orr Lake and the Sidey-Mackay sites are very close together, though exact parallels in design are hard to find. The rather high incidence of notched rims at Orr Lake is a noteworthy feature of this ware, not being found in such frequency elsewhere in Ontario.

LIST OF DECORATIVE STYLES ON ORR LAKE POTTERY

A. Shoulder Decoration

Style 1. A row of narrow triangular punctations, the upper parts of which are deeply impressed. 12 sherds. Fig. 1a.

Style 2. Two rows of narrow triangular punctations, the upper parts of which are deeply impressed. 1 sherd.

Style 3. A row of large equilateral, triangular punctations. 28 sherds. Fig. 1b.

Style 4. A band of small, right-angled triangular punctations. 21 sherds. Fig. 1c.

Style 5. Small, irregularly-shaped triangles in a row, the long sides being uppermost. 27 sherds. Fig. 1d.

Style 6. A row of small, round, punctations. 7 sherds. Fig. 1e.

Style 7. A row of nearly diamond-shaped punctations, rather large. 6 sherds. Fig. 1k.

Style 8. A row of crescentic punctations. 3 sherds.

Style 9. A row of long, lenticular punctations, sloping left. 4 sherds. Fig. 1g.

Style 10. A row of long, lenticular punctations, almost slit-like, sloping right. 7 sherds. Fig. 1m.

Style 11. A row of narrow, lenticular, vertical punctations, either long or short. 34 sherds. Fig. 1h.

Style 12. Three bands of small, rather long, vertical punctations. 1 sherd.

Style 13. One row of small, irregularly placed, more or less triangular punctations. 1 sherd.

Style 14. One row of small round punctations. 1 sherd.

Style 15. A band of hatched triangles, the hatching in alternate triangles being in opposite directions. 10 sherds. Fig. 1q.

Style 16. Triangles of open, sinistral hatching surmounted by a row of equilateral, triangular punctations. 24 sherds. Fig. 1n.

Style 17. A band of sinistrally hatched triangles, surmounted by a row of small, lenticular punctations. 2 sherds.

Style 18. A band of sinistrally hatched triangles. 1 sherd.

Style 19. A band of hatched triangles, done in opposite directions, and crossing at one point. 1 sherd.

Style 20. Open, sinistral hatching surmounted by Style 4. 11 sherds. Fig. 1o.
Style 21. A band of incised triangles or parallel zigzags, surmounted by a row of small, vertical, lenticular punctations of Style 11. 2 sherds. Fig. 1f.
Style 22. A band of sinistrally hatched triangles, surmounted by two horizontally incised lines, with a row of narrow lenticular punctations. 1 sherd.
Style 23. A band of heavy, dextral hatching (in triangles) surmounted by two horizontally incised lines with a row of small triangular punctations. 1 sherd. Fig. 1p.
Style 24. Four horizontally incised lines in a band surmounted by scalene triangular punctations in a row. 6 sherds.
Style 25. A band of three horizontally incised lines bordered on top by large scalene, triangular punctations and on the bottom by small lenticular punctations. 5 sherds. Fig. 1l.

B. NECK DECORATION

Style 26. The same as Style 48. 3 sherds.
Style 27. Horizontal, incised lines from five to seven in number, with a row of punctations encircling the neck, another row above the lines. 1 sherd.
Style 28. Hatching as in Style 37, but with a row of small punctations below. 1 sherd.
Style 29. A row of obtuse-angled triangular punctations with alternately hatched triangular plats below. 1 sherd. Fig. 1j.
Style 30. Obtuse-angled triangular punctations above, arranged in a straight line encircling the neck, with sinistral hatching below on the left, dextral on the right. 1 sherd.
Style 31. Five parallel, horizontal incised lines, bordered on the bottom by a row of lenticular punctations. 1 sherd.
Style 32. A row of triangular punctations placed below horizontally incised lines. 5 sherds.
Styles 33, 34, and 35. Widely spaced, short incised lines, varying somewhat in placement, and other features. 1, 2 and 1 sherd respectively.

C. RIM DECORATION

Style 36. More or less equidistantly spaced lines or grooves (hatching) drawn from left to right at an angle of about sixty degrees. There is a good deal of variation in size, regularity, depth and spacing of such work, but a common type forms a zone about one inch wide around the rim. 33 sherds. Fig. 2a.
Style 37. Same as Style 36, but hatched in opposite direction (sinistral hatching). 161 sherds. Fig. 2b, c.
Style 38. Vertical incised hatching similar to Style 36. 41 sherds. Fig. 2d.
Style 39. Straight incised lines similar to those in Style 36, are arranged in cross-hatching; the closeness of the arrangement varies. A reticulate design. 31 sherds. Fig. 2f.
Style 40. A variation on Style 39, in which the hatching in one direction is much sparser than in the other. 14 sherds. Fig. 2e.
Style 41. Incised chevron design, the chevrons varying in size, depth and degree of uniformity. 1 sherd.
Style 42. Broadly spaced horizontal incising. 2 sherds.
Style 43. Widely and irregularly spaced sinistral hatching. 1 sherd.
Style 44. Slightly sinistral hatching at rim meets a continuous, horizontal, incised line beneath. 1 sherd.
Style 45. Widely spaced, sinistral hatching with three horizontal, incised lines below. 1 sherd. Fig. 2k.
Style 46. Evidently a plat of horizontal, incised hatching is opposed to one of sinistral hatching. 3 sherds.

Style 47. Plain triangles (?) separated by a plat of 3 vertical hatchings, flanked by a triangle of sinistral hatching. 1 sherd.

Style 48. Triangular plats of hatching, the lines in adjacent plats being incised in opposite directions, usually at right angles to each other. Generally the plats are about equilateral with a few scalene. 31 sherds. Fig. 2h.

Style 49. Similar to Style 48. 1 sherd.

Style 50. A rare style in which incised lines form concentric open circles with three vertical strokes filling in the central space. 2 sherds (1 vessel). Fig. 2j.

Styles 51 to 55 below possess rims or "knobs", either with or without additional decoration.

Style 51. Notches protrude from around the top edge of the rim, but lack hatching. 3 sherds.

Style 52. A plain rim with either rounded or large and over-hanging notches, and one sherd with a horizontal line encircling part of the rim. 12 sherds. Fig. 3a.

Style 53. This is Style 37 with notches below. 48 sherds. Fig. 3b.

Style 54. Style 36 combined with notches of various sizes, and shapes (such as pointed, rounded, squarish and either closely or distantly spaced; grooves between notches either deep or shallow). 14 sherds. Fig. 3c.

Style 55. Hatchings of Style 40 combined with notches of Style 54 15 sherds. Fig. 3d, k.

Style 56. A band of lenticular punctations with an incised horizontal line below. 1 sherd. Fig. 3e.

Style 57. Two round punctations one above the other, arranged at intervals between two continuous, horizontal, incised lines. 1 sherd.

Style 58. Hatching in Style 36, with two horizontal grooves beneath, and a row of triangular punctations below this again. 2 sherds.

Style 59. Hatchings interrupted by deep lenticular punctations cutting lower edge and half of the rim. 1 sherd. Fig. 3j.

Style 60. Dextral hatching on the rim, with small punctations arranged in a close grid below; below this again, a pair of horizontal, straight, incised lines. 1 sherd. Fig. 4l.

Style 61. Carefully made sinistral hatching, more or less triangular in individual form, with, at the bottom of each incision, a round punctation. 1 sherd. Fig. 2g.

Style 62. Plats of vertical hatching bordered on one side by a band of short vertical, incised, horizontal lines, and on the other (probably) by a triangle of sinistral hatching. At the bottom is a band of narrow, incised, horizontal lines, with groups of punctations beneath. 2 sherds. Fig. 3h.

Style 63. Plain triangles separated from each other by plats consisting of four diagonal, parallel, incised lines; the top and bottom of alternate triangles being ornamented with a row of triangular or round punctations. 1 sherd.

Style 64. Plain triangles separated from each other by plats of 4 diagonal, incised lines; bordered at the bottom with a double row of oval punctations. 1 sherd. Fig. 3g.

Style 65. Plain triangles separated by plats of three hatched lines, the upper edge of the plats and the lower edge of the triangles being bordered with a row of ovate punctations. 2 sherds. Fig. 3f.

D. CASTELLATIONS

Style 66. On right of the peak, style 36; on left, style 37. 16 sherds. Fig. 4b.

Style 67. A chevron design crossed by two pairs of inclined, incised lines. 3 sherds.

Style 68. On right of the peak, style 37; on left, style 36. 5 sherds.

Style 69. Similar to style 63, but with vertical incision to peak. 1 sherd. Fig. 4a.

Style 70. Similar to style 63, but with coarser hatching, 3 vertical incisions, and slight cross-hatching at lower corner. 1 sherd. Fig. 4d.
Style 71. Similar to style 65, but with coarser hatching and a vertical row of punctations to the peak. 1 sherd.
Style 72. Similar to style 40, with a vertical row of punctations to the peak. 1 sherd.
Style 73. Large, deep incised lines, sinistral to the right of the peak and dextral to the left; in centre, a vertical row of punctations, bordered by incised lines. 1 sherd. Fig. 4c.
Style 74. Similar to style 63, but with coarser hatching and a vertical row of punctations to the peak. 2 sherds.
Style 75. Similar to style 63, but with a vertical band to peak, containing horizontal punctations bordered by vertically incised lines. 2 sherds. Fig. 4m.
Style 76. Style 36 alone. 3 sherds.
Style 77. Style 37, but with wider-spaced hatching. 2 sherds.
Style 78. Style 38 alone. 4 sherds.
Style 79. Style 38, with a vertical band of cross-hatching to the peak. 4 sherds. Fig. 4e.
Style 80. Style 38, with a vertical band to the peak of nearly horizontal punctations. 1 sherd. Fig. 4h.
Style 81. Heavy, carefully done incising of style 38, with one horizontally incised line crossing at centre. 1 sherd. Fig. 4f.
Style 82. Style 38, bordered by style 48. 1 sherd.
Style 83. Similar to style 77, but with larger horizontal punctations. 2 sherds.
Style 84. Right-angled cross-hatching with a central band of horizontal punctations. 1 sherd. Fig. 4g.
Style 85. On left of peak, style 37; on the right, right-angled cross-hatching; between, a band of two rows of horizontal punctations. 1 sherd.
Style 86. Hatching of style 38; a band of horizontal punctations beneath each of the two peaks. 1 sherd. Fig. 4j.
Style 87. Hatching of style 38 at left of peak; horizontal incising at right, and between, a large lenticular punctation. 1 sherd.
Style 88. Indeterminate hatching. 1 sherd.
Style 89. Faint horizontal incising bordered at bottom with a row of round punctations. (Similar to style 28). 1 sherd.
Style 90. Hatching of style 38 at left; hatching of style 36 at right and including the peak. 1 sherd.

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TRANSACTIONS

of the

Royal Canadian Institute

VOLUME XXVIII

1949-1950

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TRANSACTIONS

OF THE

Royal Canadian Institute

No. 60 | October, 1951 | Vol. XXIX, Part I

191 COLLEGE STREET
TORONTO 2B, CANADA

POPULATION TRENDS IN THE SUDBURY AREA

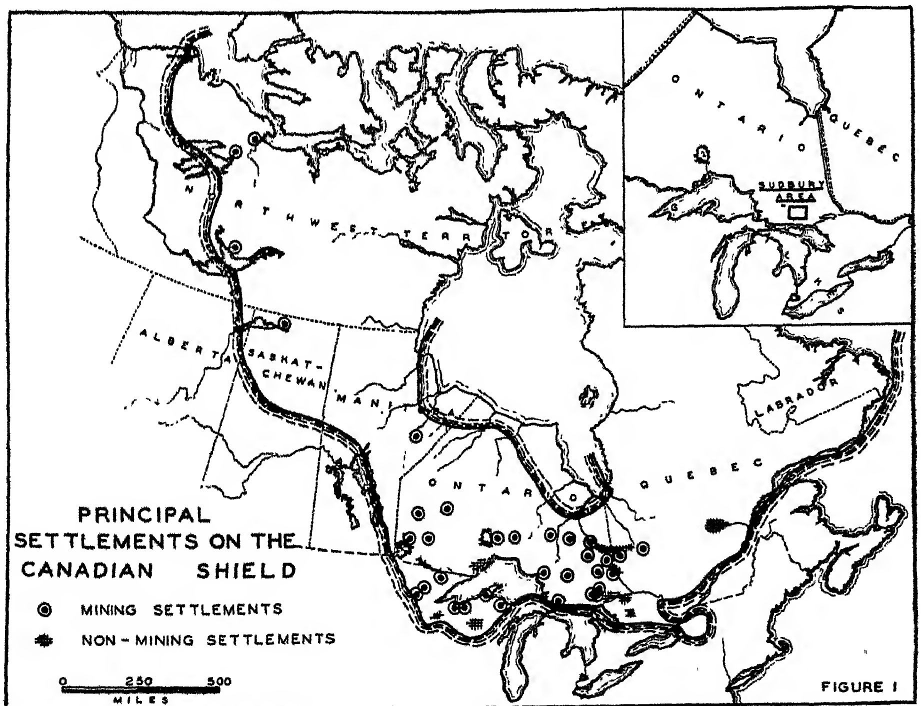
George R. Rumney

Assistant Professor of Geography, University of Connecticut

INTRODUCTION

Beyond the zones of continuous settlement in southern Ontario and Quebec, extends the rocky, forested expanse of the Canadian Shield. It is a region whose population is distributed in clusters of relative density, more or less widely separated by areas having few if any inhabitants. Most of the population clusters have developed where mining for gold, silver, cobalt, nickel, or copper is the principal economic activity, (Fig. 1). The chief mining center, and one of the larger agglomerations of settlement in this vast region is the Sudbury Area, (Fig. 2) where, in 1949, one-third of the total value of Canada's mineral output was produced. At present, about 89 per cent of the world's nickel, about 40 per cent of the world's platinum and related metals, and about half of Canada's copper are mined in this area. It is a nucleus of rapidly increasing population in the sparsely settled region of the Canadian Shield.

In the relatively short span of 66 years, the Sudbury Area has changed from the primeval haunt of fur trapper and lumberjack to a thriving industrial-commercial core of expanding population. Since 1883, when



the tracks of the Canadian Pacific Railroad were first extended across this part of Ontario toward the Pacific coast, the population of this area has grown from zero to 87,147 (in 1949).

Although closely united economically with many large industrial sections of Canada and the United States, the Sudbury Area is geographically isolated from the major population regions of North America. Located about 40 miles north of Georgian Bay and about 190 miles east of Sault Sainte Marie, it is connected by the rails of the Canadian Pacific and Canadian National Railways with the chief cities of Canada, and indirectly with those of the United States. The region in which it lies is a land of many lakes, rivers, marshes and forests. Its thinly scattered soils are associated everywhere with rounded hills and ridges of exposed bedrock. It is a land where the long, cold winters, short cool summers, and the scarcity of tillable soil, have discouraged widespread agricultural settlement. Mining is the primary basis of enduring settlement throughout most of this region, and the Sudbury Area is the chief of all the mining centers established there.

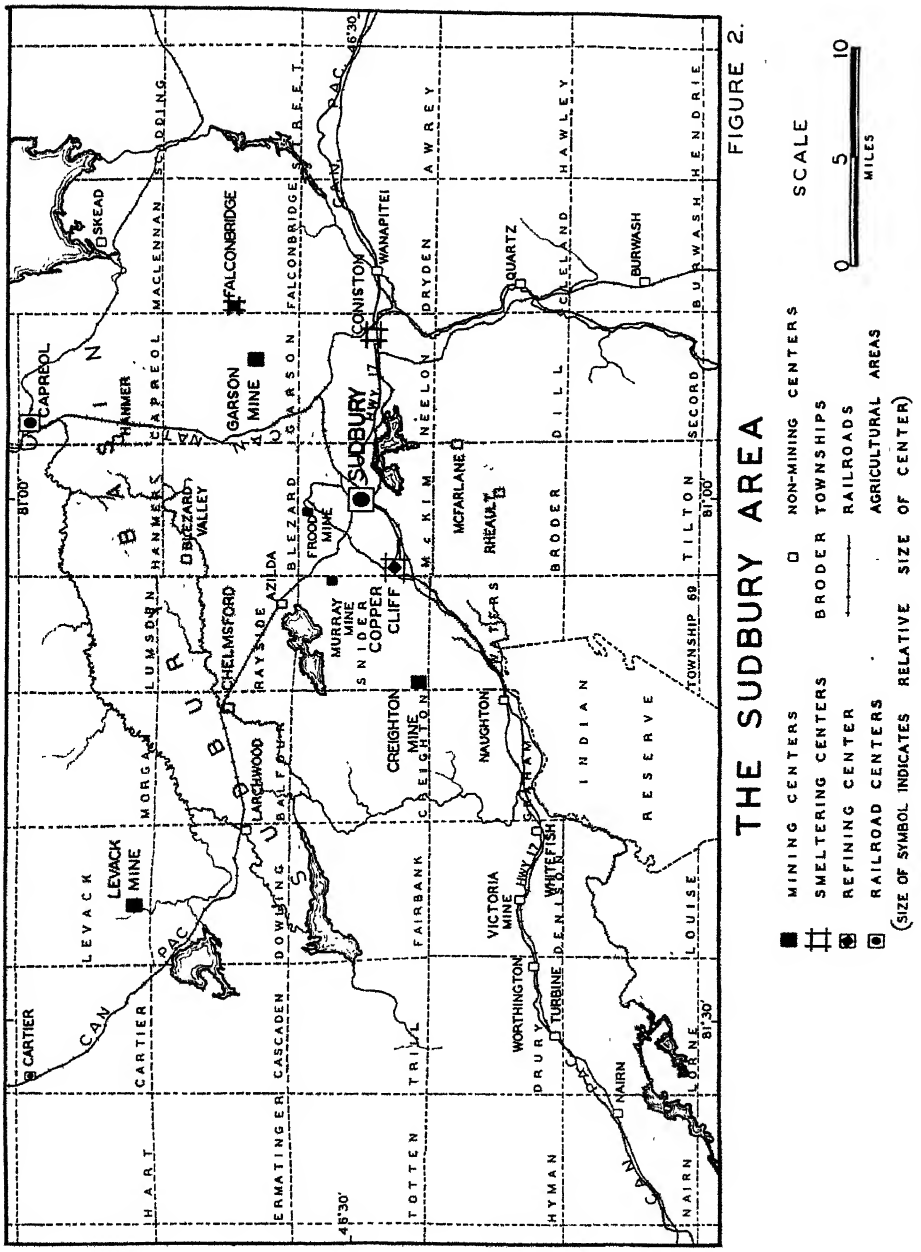
An analysis of recent population trends indicates that it is becoming an industrial settlement of unusual size and importance in a region otherwise sparsely populated. Still, in keeping with the nature of mining communities everywhere, it is foredoomed to lose population when its minerals have been consumed.

Besides the nickel-copper mines, smelters, refineries, and related workings, the population of the area is supported by railroad activities centered at the city of Sudbury, at Capreol, and Cartier (Fig. 2). The felling of trees for pulpwood, mine timbers, and lumber, is also of some importance, while farms chiefly devoted to dairying and potato production, take advantage of reliable markets at the urban centers. Of growing significance is the tourist industry, based upon the attraction of a cool summer climate and countless lakes and rivers in the surrounding forests.

POPULATION DISTRIBUTION AND ECONOMIC BASE

The map of population distribution for 1949 (Fig. 3), shows concentrations of people at nine principal centers, separated by areas of uneven population dispersion (Table I, Fig. 2). The largest center is Sudbury, a city of more than 48,000—over half the total population for the entire area. Other concentrations of settlement, all very much smaller than Sudbury, are at Copper Cliff, Coniston, Creighton Mine, Garson, Levack, Falconbridge, Capreol, and Chelmsford.

The city of Sudbury, heart of the world's chief nickel-producing region, has never had within its boundaries either mine, smelter or re-



THE SUDBURY AREA

FIGURE 2.

TABLE I

POPULATION BY CIVIL DIVISIONS IN THE SUDBURY AREA, 1891 TO 1949[1]

RURAL (TOWNSHIPS)	1891	1901	1911	1921	1931	1941	1949[2]
Awrey	—	—	19	30	31	267	292
Balfour	611	437	557	534	758	747	658
Blezard	[3]	474	456	503	523	533	552
Broder	[3]	20	238	448	528	573	601
Burwash	—	—	—	383	904	1,087	1,298
Capreol	—	—	585	660	516	556	525
Cartier	94	125	323	448	413	394	470
Cascaden	—	—	6	—	—	1	—
Cleland	—	—	22	76	142	100	121
Creighton	—	94	57	46	50	9	17
Denison	—	663	1,600	430	190	183	137
Dill	—	12	181	200	311	246	221
Dowling	—	102	296	228	161	398	225
Drury	—	117	390	473	364	318	342
Dryden	80	186	177	146	231	574	491
Ermatinger	—	—	—	—	—	—	—
Fairbank	—	—	—	82	66	76	56
Falconbridge	—	20	15	28	445	905	1,014
Garson	—	105	740	710	1,218	1,968	4,203
Graham	—	27	131	135	193	93	68
Hanmer	—	189	643	760	695	710	759
Hart	—	—	2	2	—	19	27
Hawley	—	—	13	7	10	29	36
Hendrie	—	—	11	2	—	5	—
Hyman	—	—	—	39	21	8	9
Levack	—	—	—	252	420	40[4]	40
Lorne	—	19	72	328	328	276	350
Louise	—	—	116	278	276	241	240
Lumsden	—	7	85	37	49	59	64

TABLE I (*continued*)

RURAL (*cont'd*) (TOWNSHIPS)	1891	1901	1911	1921	1931	1941	1949
McKim	2,345[5]	512	310	440	533	5,105	9,443
Maclennan	—	23	4	55	270	138	259
Morgan	—	—	—	62	81	85	92
Nairn	—	264	480	203	186	191	214
Neelon	—	140	342	1,528	2,400	1,009[6]	1,654
Rayside	—	820	865	952	1,067	962	862
Scadding	—	—	—	20	5	—	—
Secord	—	—	63	8	53	71	80
Snider	50	369	986	1,157	1,465	1,726	1,864
Street	—	—	—	1	9	30	39
Tilton	—	—	—	4	4	5	—
Totten	—	—	—	70	1	—	—
Trill	—	4	46	1	35	26	19
Waters	—	129	227	455	524	772	1,020
Township 69	—	—	—	—	—	10	6
URBAN CENTERS							
Sudbury	—	2,027	4,150	8,621	18,518	32,203	48,662
Capreol	—	—	—	1,287	1,684	1,641	1,817
Chelmsford	—	493	550	661	725	905	994
Coniston	—	—	—	—	—	2,245[6]	2,049
Copper Cliff	—	2,500	3,082	2,597	3,173	3,732	3,907
Frood Mine	—	—	—	—	173	70	94
Levack	—	—	—	—	—	895[4]	1,256
TOTAL	3,189	9,888	17,840	25,087	39,749	62,335	87,147

[1]Canada, Bureau of the Census, *Eighth Census of Canada*, 1941, Ottawa, 1942-49, Vol. II, pp. 113-116.

[2]The data for 1949 were obtained in part by direct reports from local civil authorities and in part by an appraisal of a publication entitled *Number of Householders Served from Rural Post Offices and Rural Routes in the Province of Ontario*, November, 1949, issued by the Postmaster General, and revised annually.

[3]Entered under McKim.

[4]Levack Town incorporated 1938 and detached from Levack Township.

[5]Includes Blezard, Broder, and Sudbury.

[6]Coniston Town incorporated 1934 and detached from Neelon Township.

finery. It is, however, a residential town for many who are employed in the mining activities around it, and is also the political capital and commercial center of the Sudbury Area. Although its trading area overlaps that of North Bay, eighty miles toward the east, and that of Sault Sainte Marie, about one hundred and ninety miles toward the west, its commercial influence is chiefly confined to the area shown on the map (Fig. 3). The distribution of the principal rail and motor routes outlines the extent of this area.

MAP OF POPULATION DISTRIBUTION
IN THE SUDBURY AREA — 1949

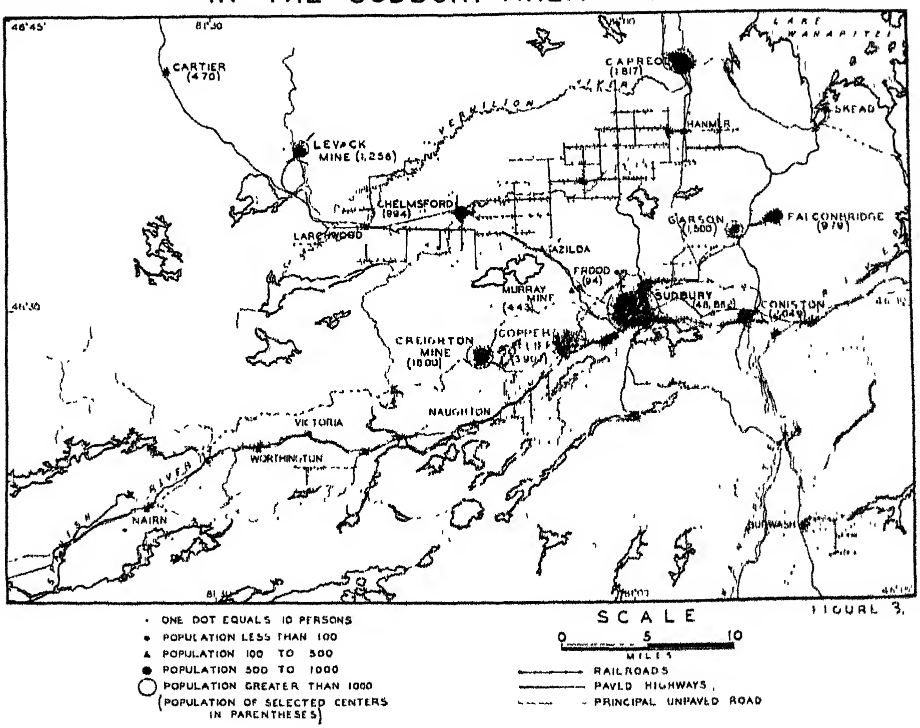


FIGURE 3.

At Creighton, Murray, Garson, Frood, and Levack are the nickel-copper mines of the International Nickel Company. Falconbridge is the site of similar mining operations and a smelter, controlled by a smaller corporation.

The populations of Copper Cliff and Coniston are supported by employment at the smelters of the International Nickel Company. At Copper Cliff there is also a refinery, an integral part of the company's plant, producing copper, gold, selenium, tellurium, and metals of the platinum-rhodium group.

Capreol is a division point on the Canadian National Railway, where employment in railroading is the main support of the population. The smaller settlement at Cartier, a division point on the Canadian Pacific Railway, is also dependent primarily upon railroading.

Nearly three-fourths of the total population in the Sudbury Area is concentrated in these mining, smelting and railroad centers. The only non-industrial settlement of importance in the area is the village of Chelmsford, a rural community serving the incidental trading needs of a large continuous farming area, the Sudbury Basin (Fig. 6), which extends for about twenty-five miles between Larchwood and Hanmer (Fig. 2). Fringed about by industrial towns and villages, the level fields of the Sudbury Basin are planted principally in oats, alfalfa, clover and potatoes. Milk and cream from the numerous dairy herds, which thrive on the oat and hay crops, are marketed at the nearby urban centres, or are processed at one of several local cheese factories. The lighter, sandier soils, which are slightly to moderately acid, produce excellent potatoes and other root crops for both local and distant markets. These are the leading uses of farm land in the Sudbury Basin. They are supplemented by the specialized production of other locally marketable items including truck crops, poultry, sheep and hogs.

French Canadians almost equal in numbers the English, Scottish and Irish elements of the population throughout the Sudbury Area, and with them, make up the chief linguistic groups. In the Sudbury Basin however, people of French origin far outnumber all others.

Beyond the Sudbury Basin are the scattered farms of the more sparsely populated areas whose products are essentially the same as those of the Sudbury Basin. Important in many of these localities are people whose heritage is neither French nor English, notably in Broder, Dill, Lorne, and Waters townships where the majority of farmers are Finnish. In common with farming practice everywhere in Northern Ontario, many farmers in the Sudbury Area must supplement their incomes by cutting timber for lumber or pulpwood in the winter time, by working in road gangs on the railroads or highways, or by finding occasional employment at the various workings of the nickel-mining companies. The importance of lumbering as an ancillary economic activity in the area, is illustrated by the presence of more than fifty sawmills of diverse size and productive capacity, more than half of which are owned and operated by farmers.[1] They supply lumber and timbers for mine construction and other building purposes, while pulpwood is transported for the most part to a pulpmill at Espanola on the Spanish River, about forty-five miles southwest of Sudbury.

[1]Information supplied by the District Forester, Sudbury District, Ontario Department of Lands and Forests.

The tourist trade, although still an infant enterprise here, is gaining importance as a source of additional income for the population of the area. It is not nearly as important around Sudbury however, as it is in the Lake Temiskaming, Lake Timagami, and Lake Nipissing Areas (15).

The present distribution of population and the pattern of economic activities in the Sudbury Area have evolved over a period of sixty-six years since the founding of the city of Sudbury as a railroad construction camp of the Canadian Pacific Railway in 1883. Indeed, the discovery of valuable nickel-copper ores near the site of the present Murray Mine in 1883, which marked the origin of the mining industry here, resulted from the exposure of a rock cut in the building of the railroad (4).

Early interest in mining at Sudbury was mainly in the production of copper, for at that time there was little demand for nickel on the world's markets. The world's annual production of nickel ore around 1890 was only 700 to 800 tons (2), compared with a production from the Sudbury mines alone in 1937 of 6,318,907 tons (12). Because the Sudbury ores contained a much larger percentage of nickel than copper, it was not until nickel had become recognized as a valuable alloy for the hardening of steel that mining in this area achieved importance. By 1900 a large number of claims had been staked and several mines were in operation, contributing to an increased world production of more than 10,000 tons per year (2). Still, nickel had few industrial uses until World War I brought a sudden demand for large quantities of nickel-steel in the manufacture of armor plate and weapons of war. The nickel-producing capacity of the mines and smelters in the Sudbury Area was taxed to the utmost and the expanded operations, requiring a greatly increased labor force, led to substantial gains in population. These gains were somewhat offset however, by losses of men to the armed forces, a situation that was repeated during the second World War, 1939 to 1945.

By 1921 the basic outlines of the present population distribution had been established. Although the nickel industry declined in the years immediately following the first World War because of a sharp drop in the military use of nickel-steels, the Sudbury Area retained its population, and, with the development of new markets for nickel, it has since continued to gain at a steadily increasing rate. In 1921, at the end of forty-eight years of settlement, there were about 25,000 people in the area (Table I). By 1949, only twenty-eight years later, this number had more than tripled, with a population increased to over 87,000.

It is the purpose of this paper to present an analysis of population trends in the Sudbury Area since 1921, and to determine from this analysis the probable growth of population in this important center of settlement in the sparsely populated region of the Canadian Shield.

POPULATION TRENDS

By far the greater share of population growth in the Sudbury Area has taken place, since 1921, at certain of the mines and smelters, and at the commercial city of Sudbury. Noticeable gains have been made in some farming areas and villages, but these are only a small fraction of the total. In spite of increases in some farming localities, there has been a slight decline in the farm population for the area as a whole.

The trend of population growth from 1883 to 1949 is illustrated by a curve, Fig. 4, from which the following facts may be observed. In 1891

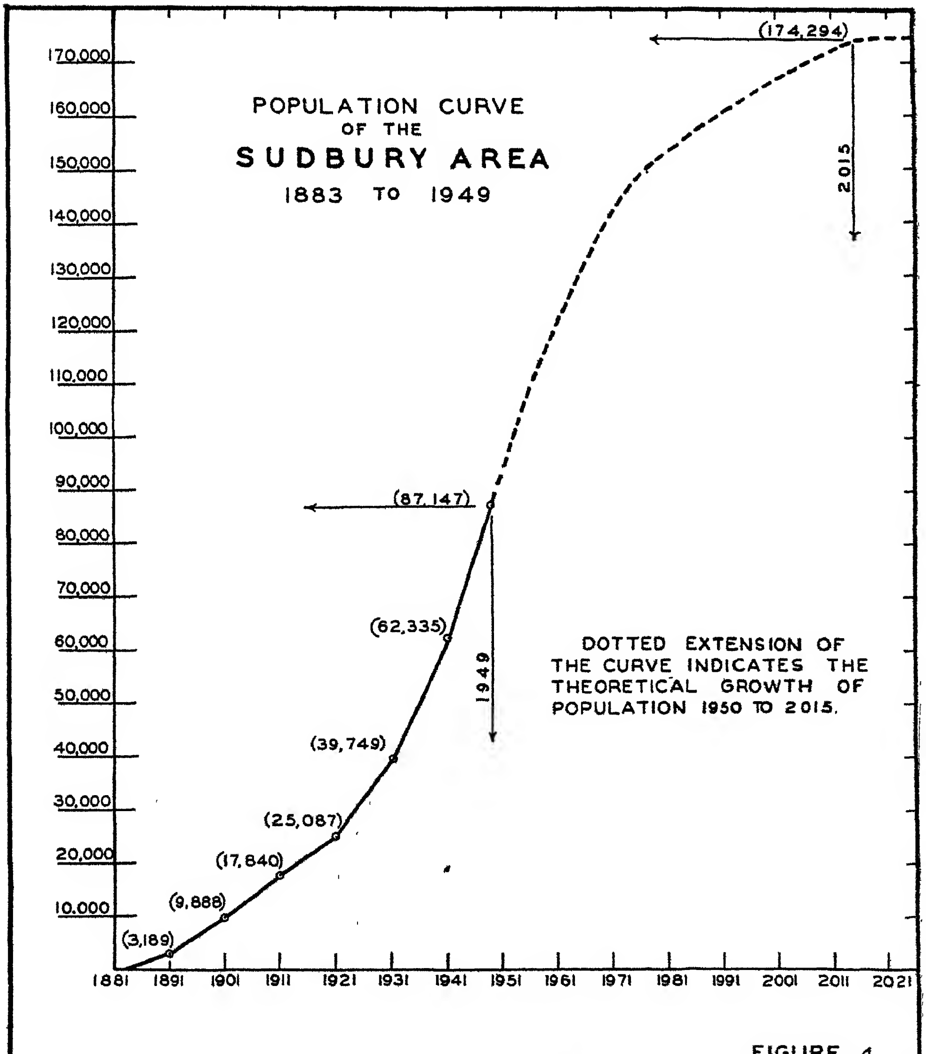


FIGURE 4.

the first official census reported a population of about 3,200 for the entire area. Subsequent decennial data indicate a fairly steady increase until 1921, although the gain per decade was considerably less than 10,000; from 1891 to 1901- 6,699; from 1901 to 1911 – 7,952; from 1911 to 1921 – 7,247. After 1921 however, the gains per decade advanced by larger increments; 14,662 from 1921 to 1931; 22,586 from 1931 to 1941; and 24,812 in the eight year period 1941 to 1949.[2]

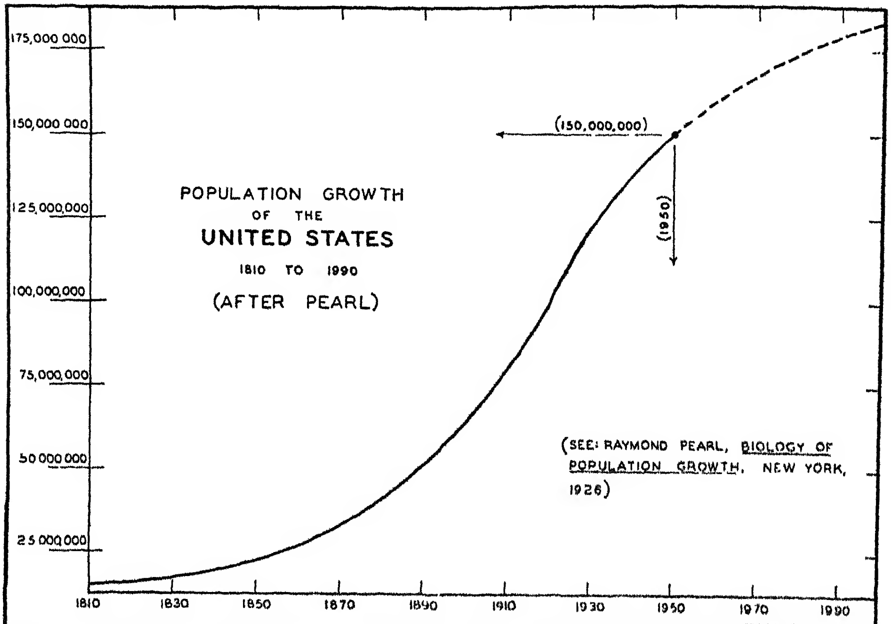


FIGURE 5

Before proceeding with an analysis of the trends thus roughly outlined for the area as a whole, it is desirable to examine in some detail the tendency toward either growth, stability, or decline in the settled portions of the Sudbury Area. For this purpose the table of population data for civil divisions and chief settlement centers is provided (Table I).

Nearly 75% of the present population is concentrated in the city of Sudbury and around the mines, smelters, and railroad towns within the area. The city of Sudbury itself, with its suburban divisions holds more than 50% of the total. Furthermore, the largest proportion of the total gain since 1921 has been made at this center. Thus the outstanding fact concerning recent population trends in the Sudbury Area as a whole, is

[2]Dominion of Canada, Bureau of the Census, Eighth Census, 1941, Vol. II, pp. 113-116. See also, Table I, page 18b footnote 2.

The map, Fig. 2, showing township boundaries, and the population curve Fig. 4, should be consulted with reference to the data in Table I, pp. 5 and 6.

FIG. 6. View northeastward across the Sudbury Basin, village of Hanmer at right. The almost uninterrupted flatness of this farming section, unusual in the Sudbury Area, has permitted the development of a rectangular road pattern. (See Fig. 3.) The enfringing rock hills are visible beyond the limit of cleared land in the distance.

the rapid growth of its chief city. In 1921 Sudbury was one of nearly thirty small towns in Ontario, each having a population of less than 10,000. According to official assessments for 1949 (6), Sudbury, with a population of 48,662, is now the sixth city in size in the Province of Ontario, and 18th in size in the entire Dominion. Its accelerated growth in recent decades is mainly the result of increased nickel ore production at Murray, Frood, Creighton, Levack, Garson, and Falconbridge mines, and expansion of the smelting operations at Copper Cliff, Coniston, and Falconbridge. With the exception of the Falconbridge mines and smelter, the mineral production of the Sudbury Area is controlled by the International Nickel Company. The chief factor in the population growth of the area has been the expanded operations of this company, highlighted by a series of events beginning in 1922 and culminating in the second World War.

In an effort to discover more industrial uses for its products, the International Nickel Company created in 1922 a Development and Research Department which played an especially vital role in the company's early peacetime expansion. The introduction of diamond drilling in 1925, and other improvements in exploratory and extractive methods led to the ultimate deepening of mine shafts and made it possible to obtain deep-lying ores that were previously inaccessible. In 1929 the

International Nickel Company gained control of all the major mining and smelting works in the Sudbury Area, when it absorbed the Mond Nickel Company, previous owners of Garson and Levack mines, and the Coniston smelter. The merger resulted in a standardization of method and equipment employed throughout the area, and led to greater efficiency in all the processes involved. The following year, a new nickel smelter and copper refinery were added to the installations at Copper Cliff. In 1931, in a further effort to concentrate the production processes at Sudbury, a major nickel-refining operation was transferred to Copper Cliff from Port Colborne, Ontario. During the war years, 1939 to 1945, the company's annual output of nickel was stepped up to capacity, averaging over fifty per cent above the pre-war yearly rate, in response to the United Nations' needs for this important metal. Concurrently the production of copper, platinum, and related metals was also greatly increased. Since the end of World War II, the International Nickel Company has undertaken the continuous improvement of its facilities in the Sudbury Area, with the deepening of old shafts at the mines, and the sinking of new ones, the building of a new concentrator at Creighton Mine, and the construction of a new oxygen flash copper smelter at Copper Cliff.

While the greater bulk of mining activity in the Sudbury Area is controlled by the International Nickel Company, the operation of the Falconbridge mines and smelter, begun in 1928, has also influenced the recent growth of population in the area. The smaller company produces less than 9 per cent of the ores mined in the area, but it supports directly, between 3500 and 4000 people by employment at its various workings (Fig. 7).

Since the city of Sudbury lies in a relatively central location, (Fig. 2) within a radius of ten miles or less of each of these centers (with the exception of Levack Mine), and is connected with them by paved highways, its facilities are easily accessible to the smaller towns. For these reasons, and because of its large business district, numerous recreational establishments, large schools and churches, and attractive suburban housing area, Sudbury is preferred as a residential center by many employees at the outlying mines and smelters.[3]

Besides providing more of the amenities of city life than the smaller towns surrounding it, Sudbury is without the transitory quality possessed by communities which have grown up around the open pits and shafts of the nickel mines, for such communities are destined to become de-

[3]The relationship between Frood Mine and Sudbury illustrates this point rather well. The Frood-Stobie open pit mine was for many years the world's largest single producer of nickel ore. The settlement around the mine has never been large however (see Table I), for most of the employees have lived in and around the city of Sudbury.

FIG. 7. Falconbridge Mines and Smelter. View northward. Mine shaft houses appear at upper left and at upper right beyond the smelter stacks. Since the prevailing winds are southwesterly, the residential section of the community has been developed to windward of the smelter stacks to minimize the unpleasant effects of the sulphurous fumes. (Sudbury Star Photo.)

populated when the local deposits of exploitable minerals are eventually consumed. Sudbury is also without the unfavorable living conditions characteristic of Copper Cliff, Coniston and Falconbridge (Fig. 8), where the sulphurous fumes from the roasting beds of the smelters create certain obvious disadvantages. In addition to the unpleasant odor in the air, the gases from the smelter produce a toxic effect upon plant life, and for many square miles downwind from the smelters, the rounded rock hills and level sandy-clay hollows are almost completely lacking in vegetation

FIG. 8. Coniston. International Nickel Company's smelter in distance. View southeastward. Smelter fumes and fine soil material carried by the prevailing southwest wind are visible to the left.

Residential area in foreground is sufficiently removed from the smelter to allow the sparse development of trees and grasses.

(Fig. 9). The virtual absence of plant life creates still a further problem by allowing even light winds to whirl great clouds of dust across the flats (Fig. 8). Thus the combination of frequent local dust storms and unpleasant odors in the air, with the great scarcity of vegetation is an environmental deterrent to a satisfactory life at the smelter towns. The resulting tendency for employees and their families to live in Sudbury away from these disadvantages, has been a significant influence in the growing concentration of people there.

Additionally important is the fact that the suburban expansion of Sudbury has been taking place in attractive residential areas like that along the wooded shores of Ramsey Lake, south of the city, where a growing number of homebuilders have been attracted by the esthetic

qualities of the landscape, sufficiently removed from the commotion of industrial activity at the mines and smelters.

Sudbury's development as the leading commercial, political, educational and religious center of the area has resulted largely from its early status as the focus of main routes connecting the area with other parts of Canada. In 1887, only four years after its founding, Sudbury became the terminus of a branch line of the Canadian Pacific Railway leading to Sault Sainte Marie (5). Other rail lines were built into the Sudbury

FIG. 9. The bare rocky knoll in the distance and the sparsely covered clay plain in foreground are typical of the lands northeast of Copper Cliff. View southwestward toward Copper Cliff. Ore train in the middle distance.

Area in later years, and the city subsequently became an important division point on the Canadian Pacific. Its expanding function as a railroad center gave Sudbury a measure of economic stability which encouraged the establishment there of a variety of small business enterprises, marking the first stage of its development as the principal trading center for the nearby mining communities.

While Sudbury has received the greatest concentration of recent population growth for the area, the mining communities of Levack, Garson, Murray, Creighton and Falconbridge, and the smeltering town of Copper Cliff have also made measurable gains since 1921 (Table I), mainly in response to the general expansion of mining activity discussed above.[4] Falconbridge Mine was the only one of the centers to begin

[4]See pages 12-14.

operations after 1921. The rest have been functioning, although not continuously, since the 1890's. Thus the increased production of nickel-copper ores has not resulted in any major shifts in the distribution of population. With the exception of the newly-founded settlement at Falconbridge, the increased mineral output has resulted mainly in a consolidation of settlement around the principal producing mines.[5]

As local deposits of ore become exhausted however, these centers may be expected to lose their populations, and new mines like that at Falconbridge will replace them.[6] Nevertheless, as long as usable ore can be supplied, the settlements around the smelters at Copper Cliff, Coniston and Falconbridge will endure. Known deposits of ore, according to a recent estimate of the International Nickel Company (16), will sustain the mineral output of the Sudbury Area at the present rate of production for at least another fifty years. As mining is preeminent in the support of population in the area, it may be inferred from this statement that the foundations of population capacity will endure for the next half-century.

Railroad activities centered at Sudbury, Capreol, and Cartier are second in importance to the mining industry in the Sudbury Area. Capreol, founded as a division point on the Canadian National Railroad in 1914, has been growing rather steadily since 1921, and is now a small town of more than 1800 (Table I). Cartier, a small railroad center on the Canadian Pacific, has remained a village of from 400 to 500 people, for the past twenty-eight years. Both of these centers, although locally important in railroad operations, have exerted only a slight influence on the trend of population growth in the Sudbury Area since 1921. The city of Sudbury however, because of its central position and its proximity to the chief mining and smelter towns, has received the greatest concentration of expanded railroad activity, providing an additional impetus to its rapid growth in recent decades.

About 93 per cent[7] of the population increase in the Sudbury Area since 1921 has taken place at Sudbury and the mining and smeltering towns around it. The remaining population growth has occurred at rural villages such as Chelmsford, Azilda, Skead, and Burwash (Fig. 2), and along the fringes of established farming areas, wherever pioneer farmers

[5]It should be noted that Murray Mine, first commercial producer, ceased production after the first World War. It was reopened during World War II however, after the discovery of new methods for treating low grade ores, and is once again the basis of an expanding settlement.

See also the footnote concerning Frood-Stobie Mine, page 14.

[6]Two smaller corporations, Nickel Offsets, Limited and Ontario Nickel Mines, Limited, have been incorporated since 1938, to exploit hitherto untried deposits. They are not however in production at the present time.

[7]More than 58,000 out of a total population increase of 62,000 has accrued at the chief industrial settlements. See Table I, pages 6 and 7, and the map, Fig. 2.

have struck out into the surrounding forests to clear scattered patches of productive land.

The farm population in general however, has declined since 1921, for the number of people on farms and the total acreage of farmland in 1941 was appreciably less than it had been twenty years earlier.[8] Since 1941, only small unimportant gains have been made in the farming areas, most of which have taken place in the townships of Balfour, Waters, Broder and Burwash (Fig. 2). The scarcity of arable land, the average growing season of about ninety days, and the acidity of the soils, limit the use of the farmland to the raising of relatively few crops and the rearing of dairy cattle.[9] These limitations, coupled with the use of new farming techniques requiring fewer workers for planting and harvesting, and the attraction of less arduous occupations in the nearby towns, have been largely responsible for the decline in farm population.

There is still uncleared, potentially useful farmland available for adventurous pioneers who would be willing to clear the forest and farm the land within the limitations existing in the Sudbury Area. Perhaps, as the urban population continues to grow, creating larger demands for their products, more farmers will appear on the land, and help to reverse the present general decline of the farm population.

Since 1921, when the major outlines of the present pattern of settlement had been established, the population of the Sudbury area has increased from 25,087 to 87,147, a gain of 62,000 (Table I). If we examine the curve, Fig. 4, expressing population growth for the area since its first settlement in 1883, and compare Fig. 4 with Pearl's idealized curve of population growth (14), Fig. 5, a distinct relationship between the two may be clearly seen. Pearl has shown, that under any given economic adjustment to the land (for example, the mining-railroad-farming economy of the Sudbury Area), population growth during the period that such an economy is dominant, develops in a fashion that can be expressed mathematically by a curve resembling an elongated S (Fig. 5). The curve, Fig. 4, is thus seen to resemble an S-curve, like that in Fig. 5. For purposes of illustration, the remaining half of the curve is plotted as a broken line, and from examination of this figure, certain observations may be made regarding the population trends for the Sudbury Area as a whole.

In general, the Sudbury Area appears to have reached about the midpoint of population growth, suggesting that during the next sixty-six years, (a period equal to the present age of the settlement), numerical

[8]Farm population in 1921, 5,885; in 1941, about 4,580. Farm land in 1921, 203,637 acres; in 1941, 160,583 acres. Canada, Bureau of the Census, *6th Census of Canada*, Vol. V, pp. 242-244; *8th Census of Canada*, Vol. LX, pp. 1042-1043.

[9]See page 9.

gains per decade will probably decrease, leading to the gradual stabilization of the population around the year 2015. The total number of people in the area would then be, theoretically, double the present figure, or 174,294. According to Pearl, stabilization would continue as long as the dominant economy of the area remained unaltered. But these hypotheses must be evaluated in the light of certain practical considerations.

Since the Sudbury Area is primarily a mining settlement, and over two-thirds of its population is supported directly by mining activities, the exhaustible nature of the mineral resources forming the basis of settlement is a fact of singular consequence in an analysis of population trends for the area. It has been noted, page 18, that the present rate of nickel-copper ore production may be continued for another half-century. Unless this appraisal is revised, a decline in mining may then be expected to begin around the end of the present century, leading to eventual abandonment of mines, smelters and refineries. The life-expectancy of the mining industry here may be extended by the discovery of new deposits of reserves or further technological improvements, or it may be reduced if the present rate of productivity is increased to answer either the peace-time or military needs for nickel, copper, platinum, and related metals. In any case, the nickel-copper deposits of the Sudbury Area must eventually be exhausted, and since most of the present population of the area is supported by the mining industry, a large decline in population may be anticipated when the mining base has been removed.

For the present however, continued gains may be expected, although at a declining rate of growth per decade until the theoretical maximum of more than 174,000 is reached around the year 2015, providing that the present economy remains essentially the same, and that major aberrations do not appear.

SUMMARY

The Sudbury Area is at present the most important mining area in Canada. It is also one of the more populous settlements on the Canadian Shield, and Sudbury, its chief city, is the largest in the Canadian portion of that sparsely populated region.

Its population has grown by continually larger increments per decade since 1921, when the present pattern of settlement had become established. An analysis of its population trends, in the light of Pearl's theory of regional population growth, indicates that the Sudbury Area may double its present population soon after the turn of the next century. This analysis is predicated however, upon the continued dominance of the present economy,—mining, railroad operation, farming, and some forest industries,—throughout the period of population increase. When

the exploitable deposits of minerals have become exhausted, however, and the mining base thus removed from the present economy, a large segment of the population will be without support. Such an important change in the economic foundation may be expected to result in a major decline in population, followed eventually by an adjustment to a new economic base. A new cycle of population growth would then develop having characteristics similar to those of the present cycle.

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THE SUMMER DRY CLIMATE OF GEORGIA BASIN, BRITISH COLUMBIA

D. P. Kerr

Department of Geography, University of Toronto

INTRODUCTION

Most of Georgia Basin in the extreme southwestern corner of British Columbia has the lowest rainfall in Canada during mid-summer.* In particular Saanich Peninsula with a little over one inch of rain has an acute moisture deficiency in July and August notwithstanding that it lies within 100 miles of the Pacific Ocean and is situated in the belt of the Westerlies. Rainfall increases in the northwestern and northeastern parts of the Basin and becomes moderately heavy along the mountain slopes.

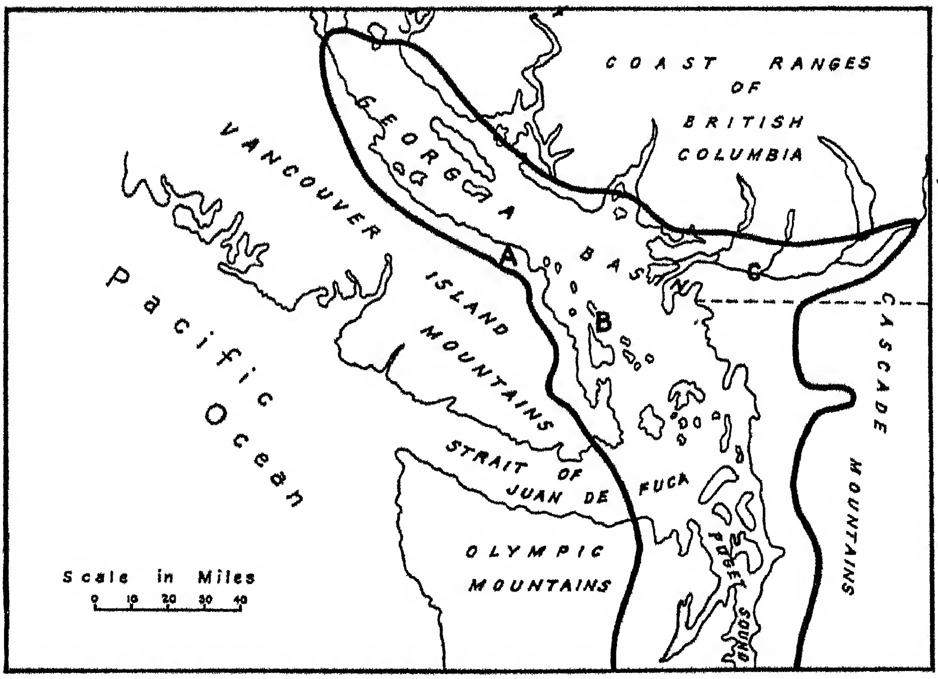

Fig. 1. Physiographic Divisions:
A. East Coast Lowland of Vancouver Island; B. Gulf Islands; C. Lower Fraser Valley.

*The summer season of 1951 was very dry. For example, Vancouver Airport recorded only 1.04 inches of rain from June 1st to August 31st and no rain from June 15th to August 12th.

TOPOGRAPHIC SETTING

Georgia Basin (Fig. 1) is a partially submerged depression lying between the mountains of Vancouver Island and the Olympic Peninsula on the southwest and the Coast-Cascade Mountains on the northeast. It is part of the Coastal Trench physiographic division and comprises: Puget Sound and Georgia Strait, and three emerged sections in British Columbia, the East Coast Lowland of Vancouver Island, the Gulf Islands and the Lower Fraser Valley. The topographic trend, as in the rest of British Columbia, is southeast-northwest.

The mountains to the southwest rise to over 2,500 feet in most sections on Vancouver Island (Fig. 2) and to over 5,000 feet on the Olympic Peninsula in Washington. The East Coast Lowland of Vancouver Island, averaging eight miles in width, is composed of many small basins separated by eastward extending spurs of the Island Mountains. Its rough topography has local climatic significance. Most of the Gulf Islands lying just off shore are monadnocks which typically rise to over 1,000 feet.

The Coast-Cascade Mountains form virtually a solid wall on the northeastern edge of Georgia Basin. The Lower Fraser Valley extends inland from the southeastern portion of the Basin. A large part of the Valley consisting of Recent delta has a flat surface and lies less than 25 feet above sea level. A raised delta averages 250 feet and has a rolling topography. Hills rise to 1,000 feet on the margins of the Valley and two mountains, Sumas and Vedder in the eastern part, exceed 2,000 feet. The Coast and Cascade Mountains reach over 5,000 feet immediately to the north and south of the Valley respectively (Fig. 2). It narrows to the east until at Hope it becomes a canyon which pierces the Coastal Mountain block.

DISTRIBUTION OF RAINFALL IN JULY AND AUGUST

July and August are the driest months throughout Georgia Basin. Less than five per cent of the annual precipitation falls during these two months; 75 per cent falls in the six month period from October to March. Fig. 3 shows the distribution of rainfall for July and August. Saanich Peninsula averages less than 1.2 inches, Nanaimo 1.7 inches, Steveston 2.1 inches, Vancouver 2.9 inches, Cumberland 3.0 inches and Chilliwack 3.2 inches. The southeastern corner of Vancouver Island is the driest section; rainfall increases to the northwest along the east coast of Vancouver Island and to the northeast in the northern and eastern sections of the Lower Fraser Valley.

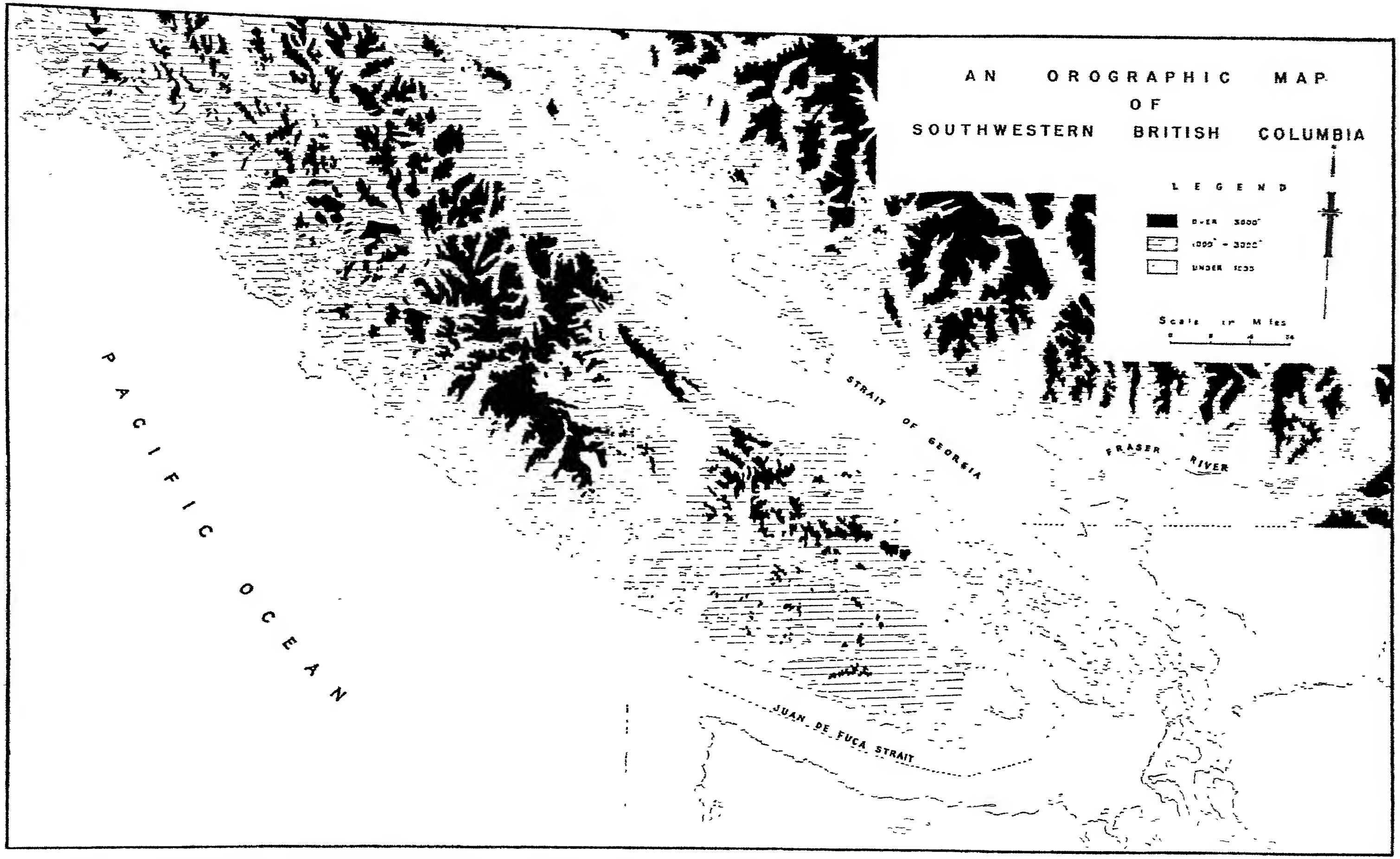

FIG. 2. An Orographic Map of Southwestern British Columbia—traced from National Topographic Series (8 miles to the inch), Dept. of Mines and Resources, Ottawa, 1947.

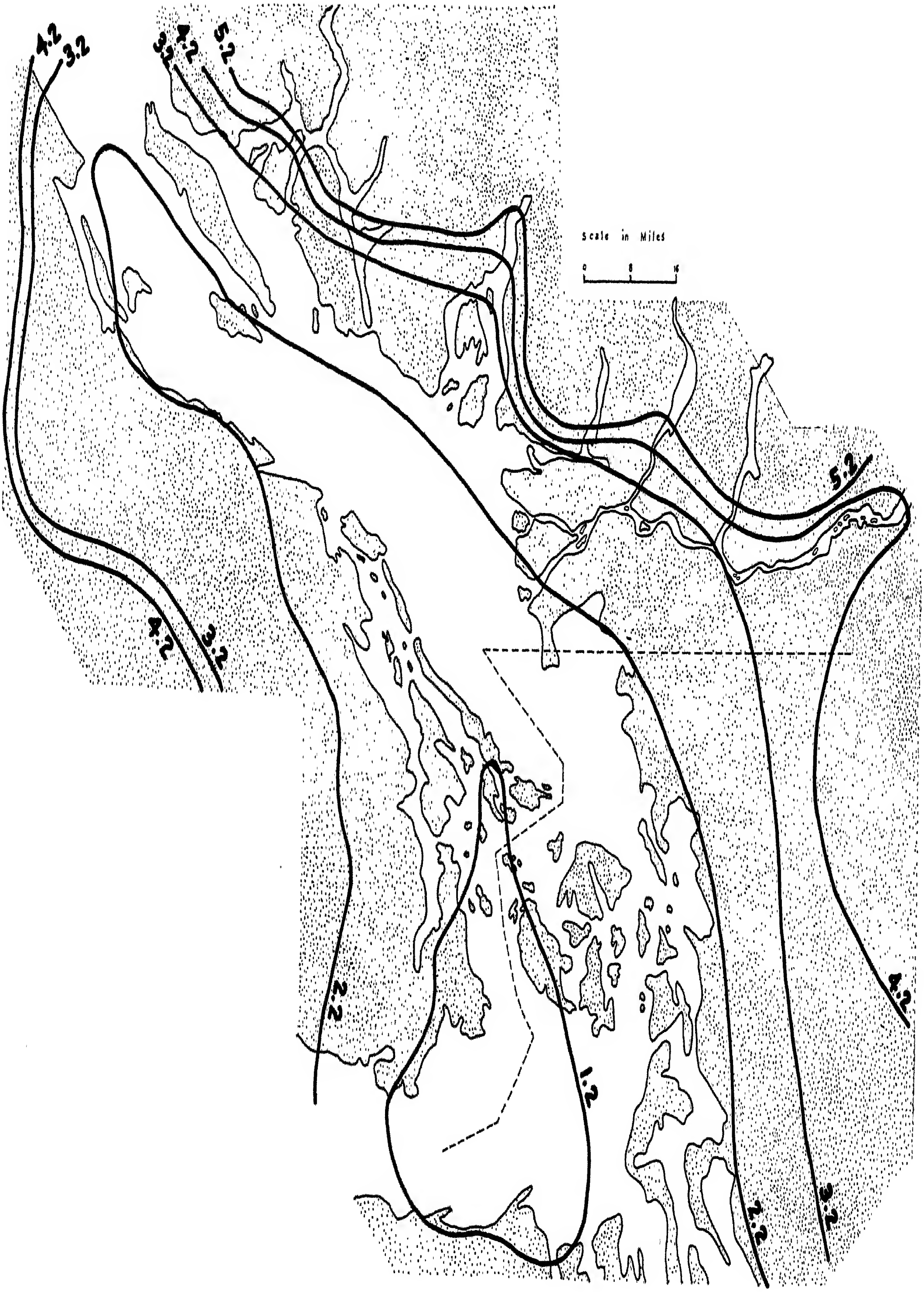

Fig. 3. Selected Isohyets (in inches) for July and August in Georgia Basin Area.

METEOROLOGICAL AND TOPOGRAPHICAL CONTROLS

The Pacific anticyclone is the dominant meteorological control in the warm season. It normally covers the entire North Pacific Ocean in July and August and consequently few frontal disturbances penetrate the southern coast of British Columbia. Northwesterly winds blow steadily along the Coast and surface water off shore is displaced to the southwest (1 & 3) resulting in an upwelling of fairly cold water. Polar Pacific air which is moderately unstable over the open ocean becomes very stable in the lower levels when it crosses the cold water. Such a condition precludes precipitation. Only a very strong onshore wind can lift the air over the coastal barrier and cause orographic rain.

Occasionally the Pacific anticyclone weakens in summer; then depressions impinge upon southern British Columbia and rain falls over the southern Coast. The southwestern slopes of the Vancouver Island and Olympic ranges receive copious amounts of rain but the northeastern slopes receive very little. The air being unstable continues to rise after being "touched off" at these topographic barriers or over the warm land. Towering cumulus and cumulonimbus clouds soon form from which heavy rain falls. To the east of the axial ranges the clouds continue to ascend but having lost much moisture on the seaward inclines flatten out to form altocumulus or, on occasion, cirrus types. As a result only a few showers occur in sheltered districts.

Saanich Peninsula, the driest section, lies directly to the northeast of the Olympic Mountains and is well protected from rain-bearing southwesterlies. To the northwest along the east coast of Vancouver Island rainfall increases for two reasons: mountains to the southwest are lower than the Olympics; the latitude is slightly higher than Saanich Peninsula and consequently there is more chance for cyclonic activity (especially trailing ends of occlusions). In the Lower Fraser Valley rainfall increases noticeably from the southwestern section to the northeastern and eastern portions. Southwesterly air currents moving into the Valley are forced to ascend at the Coast Mountains and much moisture is released. Before its rise the air probably absorbs some moisture from the Strait of Georgia, but this factor does not account for rainfall distribution in the Valley otherwise Ladner (2.2 inches in July and August) would receive as much rain as Chilliwack (3.2 inches).

RAINFALL VARIABILITY

Examination of rainfall data for Victoria and Vancouver shows that in a twenty-year period from 1918-37 negative variability at Victoria was 44 per cent, positive 34 per cent; at Vancouver negative was 42 per cent, positive 42 per cent. The arithmetical mean of rainfall (July and August)

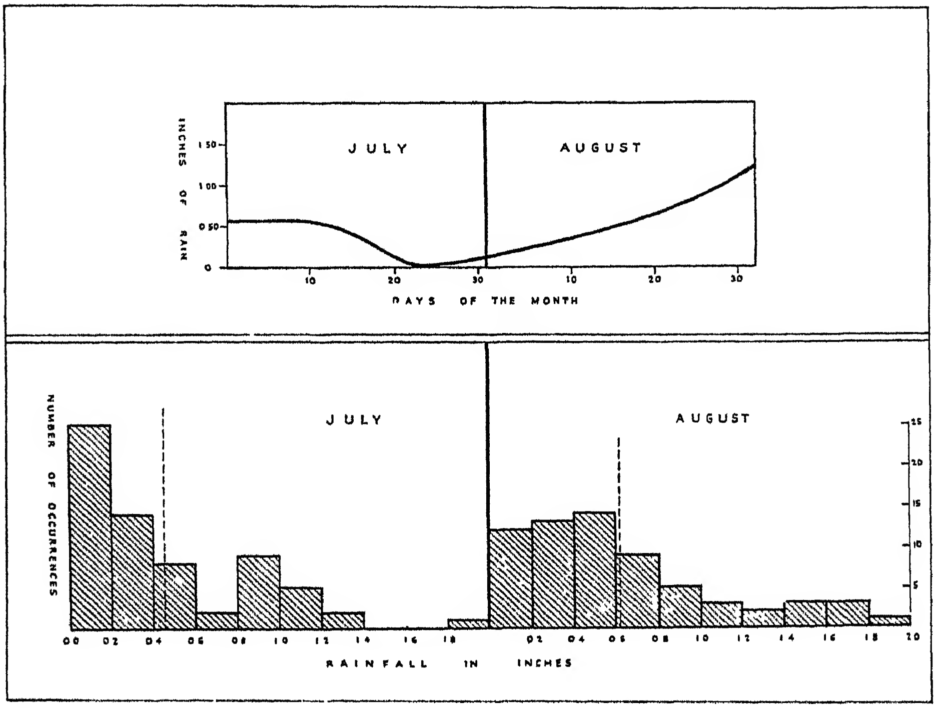

FIG. 4. (*a*) Daily distribution of rainfall at Victoria. The graph is based on the total rainfall for each day (24 hour period) from July 1 to August 31 for the period 1918-1937 (inclusive).

(*b*) Histograms of rainfall variability for Victoria for 66-year period (1882-1947). For example in July during that period the rainfall was between 0.0 and 0.2 inches in 25 years. Broken lines indicate arithmetical mean.

at Victoria for the twenty-year period was 1.16 inches, at Vancouver 3.00 inches. Rainfall was below this value for 12 of the 20 years at Victoria and for 10 years at Vancouver. The least rainfall (0.06 inches) for July and August at Victoria since records were first taken in 1882 was noted in 1893 and the most (2.80 inches) in 1932. Fig. 4b indicates graphically the rainfall variability at Victoria for July and August from 1882 to 1947.

DISTRIBUTION OF RAINFALL AT VICTORIA IN JULY AND AUGUST

Fig. 4a shows the daily distribution of rainfall at Victoria for a 20-year period (1918-37). As a rule rainfall decreases after the middle of July and begins to increase after the middle of August. In a 31 day period from July 16 to August 15 or 50 per cent of the time only 21 per cent of the rain for the 2-month period was recorded; 79 per cent in the

remaining 31 days. On the average 0.26 inches falls from July 16 to August 15 inclusive; 0.93 inches in the remaining period.

In the same twenty-year interval at Victoria the average period with rainfall less than 0.01 inches was 28 consecutive days; at Vancouver, 19 consecutive days. In 1926 at Victoria there were 47 consecutive rainless days. Rain normally falls at Victoria on only 11 days in the two-month period; or in 60 hours (2) which is approximately 4 per cent of the total number of hours. Typically Victoria has 639 hours of bright sunshine in July and August. Furthermore the ceiling is unlimited 75 per cent of the time indicating the general lack of low and middle clouds.

THE THORNTHWAITE FORMULA AS APPLIED TO THE AREA

Application of the Thornthwaite formula (1) to climatic data of the area illustrates the acute water deficiency in the summer months. Vic-

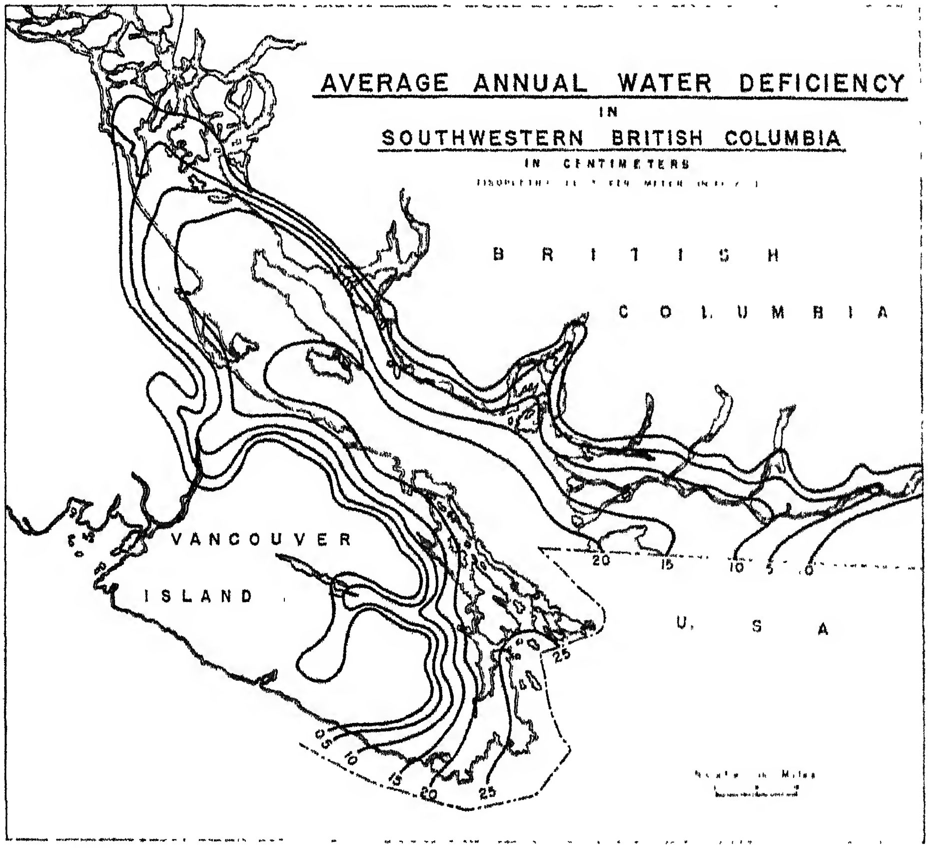

Fig. 5. Selected Isolines of Moisture Deficiency in the Area according to Thornthwaite formula.

toria has an average water deficiency of 25 centimeters (10 inches) which develops in late June and continues until mid-September. Fig. 5 shows isolines of water deficiency for the Georgia Basin Area. Greatest deficiency occurs in the southeastern part of Vancouver Island decreasing to the northwest and to the northeast in the Lower Fraser Valley.

CLIMATIC TYPES

Three fairly well-defined climatic types are found in the area: the Cool Mediterranean, the Transitional and the Maritime (Fig. 6).

The Cool Mediterranean type is confined to Saanich Peninsula. It has a Csb climate according to the Koeppen classification and $B_1B_1's_2a'$ according to the new Thornthwaite classification. Both systems accentuate the summer dry period in their definition of this particular climatic type. Normal rainfall for the two-month period (July and August) is less than 1.2 inches.

The landscape reflects the climate. Natural vegetation is a forest-grassland transition with Garry oak (*Quercus garryana*) and madrona (*Arbutus menziesii*) being the dominant trees. The oak-parkland environment possesses a profusion of flowering plants. Yellow broom (*Cytisus scorparius*) introduced almost a century ago is widespread.

Mature soils in the Saanich Peninsula area are a part of a Prairie Sub-zone of the Brown Podsolic Zone of the Pacific Coast. "They are characterized by dark brown to black surface colours with brown to yellowish sub-soils. They are moderately acid to neutral in reaction (pH 5.1 to 5.9), high in organic matter and generally low in their content of bases" (5). Downward movement of minerals is arrested because of the low rainfall in the summer months. Dehydration causes chemical precipitation in the form of iron concretions giving a yellowish to reddish brown colour in the sub soil.

The natural environment is similar in many ways to that of parts of Mediterranean Europe, Coastal California and central Chile. Summer temperatures are on the whole lower but the summer dry period is for the most part just as pronounced. The oak-parkland vegetation and the "prairie" soils with lateritic tendencies support the inclusion of the area into the Cool Mediterranean classification of climate. Situated at latitude 48° Saanich Peninsula represents the furthest poleward advance of a true Mediterranean climate on the earth's surface.

The Transitional type comprises the East Coast Lowland of Vancouver Island to just north of Comox and a narrow fringe of Mainland Coast including the extreme southwestern section of the Lower Fraser Valley. This climatic type is essentially transitional from the true Mediterranean climate of Saanich Peninsula to the fully developed

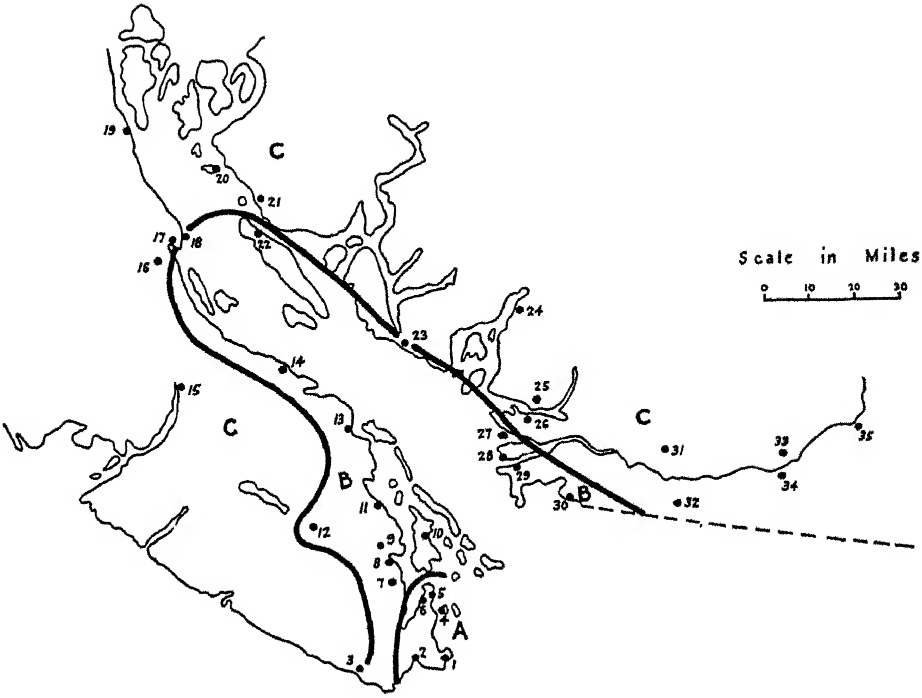

FIG. 6. Climatic Types.
A. Cool Mediterranean; B. Transitional; C. Maritime.
For list of climatic stations see accompanying key.

Key to Climatic Stations.

1. Victoria
2. Esquimalt
3. Sooke
4. James Island
5. Sidney
6. Patricia Bay Airport
7. Shawinigan Lake
8. Cowichan Bay
9. Duncan
10. Ganges
11. Chemainus
12. Cowichan Lake
13. Nanaimo
14. Parksville
15. Port Alberni
16. Cumberland
17. Comox Airport
18. Cape Lazo
19. Campbell River
20. Savary Island
21. Powell River
22. Vananda
23. Sechelt
24. Britannia Beach
25. Seymour Falls
26. Vancouver
27. Vancouver Airport
28. Steveston and Garry Point
29. Ladner
30. White Rock
31. Stave Falls
32. Abbotsford
33. Agassiz
34. Chilliwack
35. Hope

maritime climate of the remainder of the Coast. Most stations are classified as Csb (Koeppen) but as $(B_2B_3B_4)B_1'sa'$ (Thornthwaite). Normal rainfall (July and August) varies from about 1.2 inches to 2.8 inches.

Douglas fir (*Pseudotsuga taxifolia*) is the dominant species in the forest of this area. The summer period is too dry to allow the development of huge shade trees such as western red cedar (*Thuja plicata*) and

hemlock (*Tsuga heterophylla*) which prevail over the rest of the British Columbia Coast. Douglas fir, because of its light-demanding qualities, is intolerant of such species.

Mature soils are Brown Podsolic. Such soils are heavily leached, acidic and low in basic elements. However, leaching is stopped in the summer because of low rainfall and very slight laterization is evident.

The remaining parts of Georgia Basin have a Maritime type of climate: upslope on both margins to the mountains proper, and in the northern and eastern sections of the Lower Fraser Valley. Such areas are classified as Cfb (Koeppen) and $AB_1'ra'$ (Thornthwaite). Rainfall in July and August is much less than in December and January but is normally over 2.8 inches.

Douglas fir remains as the dominant species but is encroached upon by western red cedar and western hemlock in the most humid areas. Amabilis fir (*Abies amabilis*) and mountain hemlock (*Tsuga mertensiana*) are found on the higher slopes. Maple (*Acer rubrum*) and alder (*Alnus rubra*) have invaded many logged areas as a second growth. Soils are intensely leached, acidic and low in basic elements. A grayish hard-pan layer occurs from 2 to 4 feet below the surface.

In conclusion, less rain falls over Georgia Basin in July and August than on the rest of the coast of British Columbia and Saanich Peninsula is the driest part of Canada in mid-summer. The Pacific anticyclone is the principal meteorological control; topography accounts for local distribution.

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TRANSACTIONS

OF THE

Royal Canadian Institute

No. 61 | October, 1952 | Vol. XXIX, Part II

191 COLLEGE STREET
TORONTO 2B, CANADA

DESCRIPTION AND RELATIONSHIPS OF *DIROFILARIA URSI* YAMAGUTI, 1941, AND A REVIEW OF THE GENUS *DIROFILARIA* RAILLIET AND HENRY, 1911*

ROY C. ANDERSON

Department of Parasitology, Ontario Research Foundation

INTRODUCTION

On July 12, 1948, Mr. C. D. Fowle of the Department of Lands and Forests, Province of Ontario, collected several filarioid worms from the subcutaneous tissues of a black bear, *Ursus a. americanus* Pallas taken in Algonquin Park, Ontario.** Since the first discovery, these worms have been recovered in great abundance from all of some twenty bears collected in Algonquin Park by various members of the Ontario Research Foundation. Blood smears were made on which microfilariae have been found. These specimens appear to be identical to three female specimens removed from *Ursus torquatus japonicus* Schlegel from Japan and described as *Dirofilaria ursi* Yamaguti, 1941. Since Yamaguti only described the female of this species, the males and microfilariae are described herein and a more extensive description is given of the females. This species is compared with closely related species.

Since the creation of the genus in 1911 by Railliet and Henry there have been two main reviews of this genus, that of Lent and Freitas (1937) and Desportes (1940) although Faust gave an excellent review of the heartworms in 1937 and Mendonca gave a useful list of the species in 1949. However since there have been several changes in the contents of the genus since these earlier reviews and since certain points of nomenclature require clarification it seems desirable to review briefly the genus again at this time.

Through the courtesy of Dr. E. W. Price, Assistant Chief, Zoological Division, Agricultural Research Center, Beltsville, Maryland, Dr. J. F. Teixeira de Freitas, Institute of Oswaldo Cruz, Rio de Janeiro and Dr. Eduardo Caballero, University of Mexico, the writer was able to obtain specimens of *Dirofilaria repens* Railliet and Henry, 1911 and *D. acutiuscula* (Molin, 1858) for comparison with the Ontario filarids.

*The author is grateful to the Research Council of Ontario for the financial support of this work.

**This material was demonstrated at the twenty-sixth annual meeting of the American Society of Parasitologists, Chicago, Illinois, Nov. 1951. (Anderson, R. C.—A Species of *Dirofilaria* from the Black Bear (*Euarctos a. americanus*). J. Parasitol. 37: 25. Supplement, 1951.)

MATERIALS AND METHODS

Adult filariae were preserved in a mixture of 70% alcohol (85 parts) and glycerine (15 parts). Both glycerine and beechwood creosote were used individually as clearing agents. Microfilariae were studied on Giemsa-stained blood smears. The blood smears from infected bears were made some time after death and fixed a short time later.

Various types of measurements of unequal value have been used in describing species of *Dirofilaria*. In the present study most of the traditional measurements are given in order to facilitate a comparison with species described in the literature even though some measurements seem superfluous and others so variable as to be of little value. The oesophagus is not clearly divided in all species of *Dirofilaria*. To facilitate comparisons with these species, the total length of the oesophagus is given as well as the lengths of its two portions.

All data on adult worms are based on mature individuals as determined by the presence of sperm cells and embryos.

REVIEW OF THE HISTORY AND NOMENCLATURE OF THE GENUS *Dirofilaria*

The genus *Dirofilaria* was established by Railliet and Henry, 1911. They designated *D. immitis* (Leidy, 1856) as the type species and included the following in the genus: *D. magalhaesi* (R. Blanchard, 1896); *D. corynodes* (Linstow, 1899); *D. granulosa* (Linstow, 1906); *D. kuelzi* (Rodenwaldt, 1910), for *D. kuelzii* (Rodenwaldt, 1910); *D. repens* Railliet and Henry, 1911. All these species except the last were removed from the genus *Filaria* Mueller, 1787.

A few months later Railliet and Henry added *D. striata* (Molin, 1858) and *D. sudanensis* (Linstow, 1902) (see Shipley 1902), both of which had been placed previously in the genus *Filaria*.

In 1914 Neumann placed *Filaria ochmanni* Fülleborn, 1908, in the genus *Dirofilaria* although Gedoelst had correctly allocated this species to *Microfilaria* in 1911.

Stiles and Hassall in 1920 (pp. 139, 147–149) placed *Filaria recondita* Grassi, 1890 in *Dirofilaria*. These authors failed to include in their species catalogue either *D. striata* (Molin, 1858) or *D. sudanensis* (Linstow, 1902) and they made no mention of the placing of *Filaria ochmanni* Fülleborn, 1908 in the genus *Dirofilaria*.*

Boulenger in 1920 described *Filaria subcutanea* Linstow, 1899 (*nec* Parona, 1894) from the porcupine. Boulenger's material was later designated as *Filaria subdermata* by Mönnig (1924) who recognized that *Filaria subcutanea* was an occupied name. Canavan (1929) placed this species in the genus *Dirofilaria*.

*They gave erroneously the year of 1909 for *D. ochmanni*.

Yorke and Maplestone (1926) reviewed the species in the genus but neglected to list *D. ochmanni* (Fülleborn, 1908). They added the species *D. websteri* (Cobbold, 1879) and *D. scapiceps* (Leidy, 1886), that had been in the genus *Filaria* but excluded *D. recondita* (Grassi, 1890) which they placed in the genus *Dipetalonema*.

From 1926 to 1937, when Lent and Freitas published their review of the genus, the following two species were removed from the genus *Filaria* and placed in *Dirofilaria*: *D. acutiuscula* (Molin, 1858) Chitwood, 1933; *D. spirocauda* (Leidy, 1858) *sub judice* Faust, 1937. During the same period several new species were described: *D. nasuae* Mazza, 1926; *D. genettae* Baylis, 1928; *D.* (?) *digitata* Chandler, 1929; *D. spinosa* Canavan, 1929; *D. hystrix* Canavan, 1929; *D. pongoi* Vogel and Vogelsang, 1930; *D. bonnei* Vogel and Vogelsang, 1930; *D. macacae* Sandground, 1933; *D. pagumae* Sandground, 1933; *D. minor* Sandground, 1933; *D. indica* Chakravarty, 1936.

Lent and Freitas (1937, pp. 45, 48–49) reduced *D. nasuae* to a synonym of *D. immitis* (Leidy, 1856) and *D. hystrix* Canavan, 1929, to a synonym of *D. spinosa* Canavan, 1929. They did not mention *D. ochmanni* (Fülleborn, 1908) or *D. subdermata* (Mönnig, 1924) in their review. They likewise did not refer to Faust's placement of *D. spirocauda* (Leidy, 1858) *sub judice*.

Faust (1937), in the same year that Lent and Freitas presented their review, proposed that the genus *Dirofilaria* be split into the two subgenera *Dirofilaria* and *Nochtiella*. To the subgenus *Dirofilaria* he designated *D. immitis* (Leidy, 1856) as the type and to the subgenus *Nochtiella*, *D. repens* Railliet and Henry, 1911. He placed the heart worms in the subgenus *Dirofilaria*, namely: *D. immitis* (Leidy, 1856); *D. magalhaesi* (R. Blanchard, 1896); *D. pongoi* Vogel and Vogelsang, 1930; *D. spirocauda* (Leidy, 1858) *sub judice*. This author did not include *D. nasuae* Mazza, 1926 and *D. indica* Chakravarty, 1936, two heartworms which were considered valid at that time. The remainder of the species, which occur in subcutaneous and cutaneous tissue, he placed in the subgenus *Nochtiella*.

From 1937 up to the time of writing a number of species have been described as new and placed in the genus *Dirofilaria*, namely: *D. asymmetrica* Kreis, 1938; *D. schoutendeni* Vuylsteke and Rodhain, 1938; *D. louisianensis* Faust, Thomas and Jones, 1941; *D. ursi* Yamaguti, 1941; *D. tenuis* Chandler, 1942; *D. freitasi* Machado de Mendonca, 1949; *D. spectans* Freitas and Lent, 1949. In addition the following species were removed from the genus *Filaria* and placed in the genus *Dirofilaria*: *D. incrassata* (Molin, 1858) Sandground, 1938; *D. conjunctivae* (Addario, 1885) Desportes, 1940. *D. louisianensis* was placed by Faust in the subgenus *Dirofilaria*. The remainder of those described since 1937, except

D. freitasi and *D. spectans*, which belong in the subgenus *Dirofilaria*, may be referred to the subgenus *Nochtiella*.

Johnson and Mawson (1938) placed *D. websteri* as a synonym of *Dipetalonema roemeri* (Linstow, 1905). Baylis (1939, p. 3) reduced *D. indica* Chakravarty, 1936, to synonymy with *D. immitis* (Leidy, 1856). This same author (p. 5) placed, with qualification, *D. ochmanni* (Fülleborn, 1908) as a synonym of *D. repens* Railliet and Henry, 1911. Desportes (1940) considered *D.* (?) *digitata* to be more akin to *Dirofilariaformia* Lubimov than to *Dirofilaria*. Finally, Sandosham (1951, pp. 23-25, fig. 2) reduced *D. pongoi* Vogel and Vogelsang, 1930 to a synonym of *D. immitis* (Leidy, 1856).

SPECIES IN THE SUBGENUS DIROFILARIA

1. *D. immitis* (Leidy, 1856)

Filaria canis cordis Leidy, 1850, p. 118
Filaria papillosa haematica canis-domestica Gruby and Delafond, 1852 (nec *F. papillosa* Rudolphi, 1802), pp. 9-14
Filaria immitis Leidy, 1856, p. 55
Filaria spirocauda Leidy, 1858, p. 112
Filaria cordis phocae Joly, 1858, pp. 166-180, pl. 1B, Figs. 1-6
Filaria papillosa haematica Schneider, 1866, p. 87
Filaria haematica Leuckart, 1867, p. 102
Filaria sanquinis Cobbold, 1869, pp. 48, 62-3
Filaria hebetata Cobbold, 1873, p. 676
Filaria spirocauda Cobbold, 1879, p. 314
Filaria sp. Horst, 1889, p. 16
Dirofilaria immitis (Leidy, 1856) Railliet and Henry, 1911, p. 386
Microfilaria immitis Neumann and Mayer, 1914, pp. 370, 383, 406
Dirofilaria nasuae Mazza, 1926, pp. 35-41, 9 figs.
Dirofilaria pongoi Vogel and Vogelsang, 1930, pp. 480-3, Figs. 1-2
Dirofilaria indica Chakravarty, 1936, pp. 57-60, Figs. 1-2
Dirofilaria spirocauda (Leidy) sub judice Faust, 1937, pp. 131-9

Hosts: *Canis familiaris* L., *C. floridanus* Miller, *C. brachyurus* (= *Chrysocyon brachyurus*), *C. dingo* Meyer, *C.* sp. (Japanese wolf), *C. occidentalis* Richardson, *Vulpes vulpes* (L.), *Felis catus domesticus* L., *F. onca* (= *Panthera onca*), *F. tigris* (= *Panthera tigris*), *Nasua* sp., *N. narica* (L.), *Pongo pygmaeus* (Hoppius), *Ondatra zibethica L.*, *Zalophus californianus* (Lesson), *Phoca vitulina* L., *Cystophora cristata* (Erxleben)

Distribution: Cosmopolitan

In 1858, Leidy described as *Filaria spirocauda* worms removed from the heart of the common seal (*Phoca vitulina*). Joly (1858) described the worm as *Filaria cordis phocae*. Cobbold collected this worm from the right ventricle of the crested seal (*Stemmatopus cristatus* = *Cystophora cristata*). He first named it *Filaria hebetata* but later referred it to Leidy's

species. Railliet (1899) provided the first morphological description of this species and reported that he had observed the worm in Paris. Faust (1937) concluded, on the basis of Railliet's description, that the filaria described by the latter belonged in the genus *Dirofilaria*. Faust showed that a filaria from the heart of the California sea lion (*Zalophus californianus*) was indistinguishable from the type material of *D. immitis*. Since the type material of *Filaria spirocauda* has not been located the systematic position of this species is questionable. Faust considered the evidence strong enough to warrant the placing of Leidy's species as *sub judice* in the genus *Dirofilaria*. As early as 1925, however, Joest reported the occurrence of *D. immitis* in the heart of *Phoca vitulina* and later Bisbocci (1939) also reported *D. immitis* in this same host. *D. spirocauda* is probably a synonym of *D. immitis* and it is placed as such here.

Desportes (1940, p. 515) doubted the placing of *D. nasuae* by Lent and Freitas (1937) as a synonym of *D. immitis*. He considered that the figures given of this worm by Mazza (1926), if accurate, offered sufficient justification for keeping these worms separate. The discovery by Caballero (1944, pp. 109–114) of *D. immitis* in the heart of *Nasua narica* from Mexico would tend to strengthen the decision of Lent and Freitas.

Faust (1937) reviewed and added to the known host distribution of *D. immitis*. Goble (1942) reported for the first time the occurrence of *D. immitis* in the muskrat.

2. *D. magalhaesi* (R. Blanchard, 1896)

Filaria magalhaesi R. Blanchard, 1896, pp. 771, 782–3
Dirofilaria magalhaesi (R. Blanchard, 1896) Railliet and Henry, 1911, p. 386

Host: *Homo sapiens* L.
Distribution: Brazil

3. *D. louisianensis* Faust, Thomas and Jones, 1941

Dirofilaria louisianensis Faust et al., 1941, pp. 115–122, Figs. 1–2

Host: *Homo sapiens* L.
Distribution: United States

In 1941 Faust described a case of human heartworm infection from an aged woman and life-time resident of New Orleans, Louisiana. He described the single male specimen as *D. louisianensis*. Earlier de Magalhaes (1887) had recovered a single male and a single female from the heart of a child in Rio de Janeiro. Blanchard (1896) proposed the name *Filaria magalhaesi* for these worms. They were later placed in the genus *Dirofilaria* by Railliet and Henry (1911), and in the subgenus *Dirofilaria* by Faust (1937). These two records apparently represent the only known occurrence of a member of this genus in the heart of man. Faust (1937)

concluded that the incidence of human heartworm infection must be exceedingly rare. If, as Faust pointed out, de Magalhaes' worm and that from New Orleans could be identified as *D. immitis* an explanation of the two isolated human infections would be readily afforded ". . . namely that this worm, which is a common parasite of dogs in South America and southern United States, may, under appropriate circumstances, become a parasite of man." Although both species have affinities with *D. immitis* the present specific criteria seem to require that these filariae be regarded as distinct from each other and *D. immitis*. The discovery of *D. immitis* (syn. *D. pongoi*) in the heart of the orang-utan (*Pongo pygmaeus*) by Vogel and Vogelsang (1930) and Sandosham (1951) is of interest as it shows that the dog heartworm may occasionally parasitize members of the order Primates.

4. *D. freitasi* Machado de Mendonca, 1949

Dirofilaria freitasi Machado de Mendonca, 1949, pp. 647-651, pl. 1-2, Figs. 1-2

Host: *Bradypus tridactylus* L.

Distribution: Brazil

This species, which is very akin to *D. immitis*, is the only species in the subgenus *Dirofilaria* that has not been reported from the heart or major blood vessels of the host, having been collected from the abdominal cavity. Dibbell (1951, p. 298), however, has reported, apparently for the first time, the occurrence of *D. immitis* in the abdominal cavity of its host, a 9-month-old dog.

5. *D. spectans* Freitas and Lent, 1949

Dirofilaria spectans Freitas and Lent, 1949, pp. 377-380, Figs. 1-12

Host: *Pteronura brasiliensis* Zim.

Distribution: Brazil

Like the above species *D. spectans* is extremely similar to *D. immitis*. It is presumably distinguished from it in the distribution of the genital papillae. It has been collected from the right ventricle and pulmonary arteries.

SPECIES IN THE SUBGENUS NOCHTIELLA

1. *D. acutiuscula* (Molin, 1858)

Filaria acutiuscula Molin, 1858, p. 388
Filaria suis-tayassu M.C.V. in Molin, 1858, p. 388
Filaria suis-labiata M.C.V. in Molin, 1858, p. 388
Filaria canis M.C.V. in Molin, 1858, p. 388
Filaria dolichosoma Stossich, 1902, pp. 11-12

Filaria sp. Plimmer, 1912, p. 407
Microfilaria spp. Carina and Maciel, 1917, pp. 734–6
Microfilaria unicaudata Mazza, Romana and Fiora, 1932, pp. 991, Fig. 1
Dirofilaria acutiuscula (Molin, 1858) Chitwood, 1933, p. 63
Filaria canis Stiles and Baker, 1935, pp. 982, 1102, 1110
Filaria acutiuscula (Molin) Stiles and Baker, 1935, pp. 982, 1102, 1110

Hosts: *Tayassus tajacu* (L.), *T. albirostris* (Illig.)
Distribution: South America

Lent and Freitas (1937) discuss this species at length in their review of the genus *Dirofilaria.*

2. *D. incrassata* (Molin, 1858)

Filaria incrassata Molin, 1858, p. 389
Dirofilaria incrassata (Molin, 1858) Sandground, 1938, p. 422

Hosts: *Bradypus tridactylus* L., *Nasua narica* (L.), *N. rufa* Desm.
Distribution: Brazil and Central America

Caballero (1947) gives a much needed redescription of this species.

3. *D. scapiceps* (Leidy, 1886)

Filaria scapiceps Leidy, 1886, p. 308, Fig. 1
Filaria scapiceps vide Hall, 1916, pp. 180, 185–7, Figs. 243–6
Dirofilaria scapiceps (Leidy) Yorke and Maplestone, 1926, p. 394
(?) *Microfilaria* sp. Schwartz and Alicata, 1931, pp. 299–303, Fig. 1

Hosts: *Lepus sylvaticus* Dachn., *L. campestris* Dachn., *Sylvilagus floridanus alacer* (Bangs), *S. floridanus mallurus* (Thomas)
Distribution: North America

4. *D. corynodes* (Linstow, 1899)

Filaria corynodes Linstow, 1899, pp. 23, 28, pl. 6, Fig. 66
Filaria corynodes Linstow, 1903, p. 116
Dirofilaria corynodes (Linstow) Railliet and Henry, 1911, p. 386

Hosts: *Cercocebus fuliginosus* Geoff., *Cercopithecus campbelli* Waterh., *C. nictitans* L., *Semnopithecus albocinereus* Desm.
Distribution: Africa

5. *D. sudanensis* (Linstow, 1902)

Filaria sudanensis Linstow 1902, see Shipley, 1902, pp. 605–6, pl. 7, Fig. 9
Dirofilaria sudanensis (Linstow) Railliet and Henry, 1911, p. 487

Hosts: *Felis leo* L. (= *Panthera leo*), (?) *Hyaena* sp.
Distribution: Africa

6. *D. granulosa* (Linstow, 1906)

Filaria granulosa Linstow, 1906, pp. 256–7, Fig. 18
Dirofilaria granulosa (Linstow) Railliet and Henry, 1911, p. 386

Hosts: *Felis pardus L.*
Distribution: Asia

7. *D. kuelzii* (Rodenwaldt, 1910)

Filaria kuelzii Rodenwaldt, 1910, pp. 529–535, Figs. 1–6
Dirofilaria kuelzi (Rodenwaldt) Railliet and Henry, 1911, p. 386
Dirofilaria kuelzii (Rodenwaldt) Seurat, 1916, p. 344
Dirofilaria kuelzi (Rodenwaldt) Lent and Freitas, 1937, p. 47
Dirofilaria kuelzi (Rodenwaldt) Desportes, 1940, p. 521

Host: *Cephalophus maxwelli* Smith
Distribution: Africa

F. kuelzii was first described from *Cephalophus maxwelli* by Rodenwaldt (1910). Railliet and Henry (1911) misspelled the specific name *kuelzii* and used the name *kuelzi* for the same worm which they placed in *Dirofilaria*. Seurat (1916) gave the combination *D. kuelzii* (Rodenwaldt, 1910) to the same species. Both Lent and Freitas (1937) and Desportes (1940) referred incorrectly to the worm as *D. kuelzi*. Seurat is given credit for placing the species in *Dirofilaria* since he was the first to use the correct specific name with the generic name *Dirofilaria*. Following the procedure of Stiles and Hassall (1920, p. 345) the correct combination for the *Dirofilaria* occurring in *Cephalophus maxwelli* is given here as *D. kuelzii* (Rodenwaldt, 1910) Seurat, 1916.

8. *D. repens* Railliet and Henry, 1911

Filaria conjunctivae Addario, 1885, p. 134
Dirofilaria repens Railliet and Henry, 1911, p. 387
Dirofilaria repens Railliet and Henry, 1911, pp. 485–487
Filaria repens Braun, 1915, p. 313 (nec *D. repens* Railliet and Henry, 1911)
Dirofilaria repens Railliet and Henry, Vogel, 1927, pp. 85, 86–7, Figs. 9–10
Dirofilaria acutiuscula Mönnig, 1934, pp. 241–2 (nec Molin, 1858)
Dirofilaria acutiuscula Neveu-Lemaire, 1936, pp. 1126–8, 1367, 1453, 1454 (nec Molin, 1858)
Dirofilaria conjunctivae (Addario, 1885) Desportes, 1940, pp. 380–404, Figs. 1–5

Hosts: *Canis familiaris* L., *Homo sapiens* L.
Distribution: Cosmopolitan

Chitwood (1933) concluded that *D. repens* was a synonym of *D. acutiuscula* (Molin, 1858) but Lent and Freitas (1937) have pointed out differences which seem to justify the retention of the two species. Mönnig (1934) and Neveu-Lemaire (1936) accepted the synonymy of Chitwood and the name of *D. acutiuscula* associated with these authors' names is placed in the synonymy of *D. repens*. It is interesting to note that

Chitwood based his conclusion on subcutaneous worms found in *Lynx canadensis* which he believed were indistinguishable from both *D. repens* and *D. acutiuscula*. This would suggest that one of these species, more probably the former, may parasitize *Lynx canadensis*.

Skrjabin, Althausen and Schulman (1930, pp. 9–11) reported the first case of *D. repens* in man. Later Harent and Brés (1946, pp. 303–318) described the occurrence of *D. repens* in a soldier and suggested that many previous cases diagnosed as *D. conjunctivae* (Addario, 1885) may be really infections with *D. repens*. Skrjabin (1947) re-examined the systematic position of the immature female filariids frequently referred to as *D. conjunctivae* and concluded that these worms should be regarded as belonging to *D. repens*. These findings are in agreement with those of Desportes (1940) who concluded that this filaria could not be distinguished from *D. repens* on any morphological basis. Kotlan (1951) described a male filarioid worm from a human in Hungary and although a specific determination was not made the striking similarity of this specimen to both *D. repens* and *D. conjunctivae* was noted.*

9. *D. subdermata* (Mönnig, 1924)

Filaria subcutanea Linstow, 1899, pp. 23, 28, pl. 6, Fig. 72 (nec Parona, 1894)
Microfilaria sp. Plimmer, 1915, pp. 123–130
Filaria subcutanea vide Hall, 1916, pp. 180–183, 190, Fig. 240
Filaria subcutanea vide Boulenger, 1920, pp. 492–4, Figs. 1–2
Filaria subdermata Mönnig, 1924, p. 454
Dirofilaria subcutanea (Linstow, 1899) Canavan, 1929, pp. 91–1
Dirofilaria subcutanea (Linstow, 1899) Boulenger, 1920 (vide Canavan, 1929, pp. 91–4)
Dirofilaria spinosa Canavan, 1929, pp. 91–3, 101–2, pl. 5, Figs. 10–14, pl. 8, Fig. 47
Dirofilaria hystrix Canavan, 1929, p. 92
Dirofilaria repens Canavan, 1931, p. 222 (nec Railliet and Henry, 1911)

Host: *Erethizon dorsatum L.*

Distribution: North America

Plimmer (1915) reported the occurrence of microfilariae in the blood of a Canada porcupine (*Erethizon dorsatum*). Later Boulenger (1920) collected and described worms from the subcutaneous tissue of this same animal. He referred these specimens to *Filaria subcutanea* Linstow, 1899 (*nec* Parona, 1894). Hall (1916) had suggested earlier that *F. subcutanea* Linstow, 1899 from the porcupine was probably a synonym of *Filaria martes* Gmelin, 1790, from *Hystrix cristata*. He also pointed out that

*After this paper had gone to press two papers relevant to the taxonomy of *D. conjunctivae* have come to the writer's attention: (1) López-Neyra, C. R. and Balcázar Rubio, M.———"La dirofilariosis conjunctival, nueva afección humana". Revista Ibérica de Parasitologia, 11:369-386. 1951. (2) Faust, E. C. *et. al.*———"Unusual findings of filarial infection in man". American Journal of Tropical Medicine and Hygiene, 1:239-249. 1952.

F. subcutanea Linstow, 1899, was a homonym of *F. subcutanea* Parona, 1894, which is a synonym of *F. martes*. Hall advised against renaming Linstow's material until its relationship with *F. martes* was ascertained. Mönnig (1924) gave a detailed description of *Filaria martes* Gmelin, 1790, and noted that the worm described by Boulenger was distinct from *F. martes*. Accordingly he proposed the combination *Filaria subdermata* (syn. *F. subcutanea* v. Linstow, 1899) for the porcupine material. Canavan (1929) considered Boulenger's specimens to be distinct from von Linstow's and apparently in ignorance of Mönnig's combination he proposed the new combination of *Dirofilaria hystrix* n. sp. for these specimens. Canavan gave the erroneous citation *Dirofilaria subcutanea* (Linstow, 1899) Boulenger, 1920, thus implying that Boulenger had made the combination with *Dirofilaria*. Actually Boulenger was convinced of the identity of his material with *Filaria subcutanea* Linstow, 1899 and there is no evidence that he ever placed this species in the genus *Dirofilaria*. It now seems likely that Canavan was the first to recognize that this species belonged in *Dirofilaria*. In addition to renaming Boulenger's specimens, Canavan also designated some of his material from the porcupine as *Dirofilaria spinosa* n. sp. Two years later he reported *Dirofilaria repens* Railliet and Henry, 1911, from the porcupine.

Lent and Freitas (1937, pp. 48–49) considered *Filaria subcutanea* as an occupied name and *D. hystrix* and Canavan's *D. repens* Railliet and Henry, 1911 as slight variants of the species occurring in the porcupine which they designated as *D. spinosa* Canavan, 1929. Lent and Freitas were apparently unaware of Mönnig's earlier combination. The complete citation for the *Dirofilaria* occurring in the porcupine is *D. subdermata* (Mönnig, 1924) Canavan, 1929.

Desportes (1940, pp. 521 2) accepted the nomenclature of Canavan and Lent and Freitas in discussing this species.

Machado de Mendonca (1948, pp. 647–651), in listing the species in *Dirofilaria* gave the citation "*D. subdermata* Mönnig, 1924" apparently in reference to this species.

10. *D. genettae* Baylis, 1928

Dirofilaria genettae Baylis, 1928, pp. 295–6, Fig. 17

Host: *Genetta tigrina pardina* (= *G. stulmanni pardina?*)
Distribution: Nigeria

11. *D. bonnei* Vogel and Vogelsang, 1930

Dirofilaria bonnei Vogel and Vogelsang, 1930, pp. 483–5, Figs. 3–4

Host: *Mus rattus* L.
Distribution: Java

12. *D. macacae* Sandground, 1933

Dirofilaria macacae Sandground, 1933, pp. 575, 579, Fig. 28

Host: *Macaca assamensis coolidgei* (McClelland)
Distribution: Indochina

13. *D. pagumae* Sandground, 1933

Dirofilaria pagumae Sandground, 1933, pp. 575-6, 579, Fig. 29

Host: *Paguma larvata* Gray
Distribution: Indochina

14. *D. minor* Sandground, 1933

Dirofilaria minor Sandground, 1933, pp. 575-6, 579, Fig. 30

Host: *Felis bengalensis* Kerr
Distribution: Indochina

15. *D. asymmetrica* Kreis, 1938

Dirofilaria asymmetrica Kreis, 1938, pp. 346–9, Fig. 11

Host: *Cephalophus grimmia* L.
Distribution: Africa

16. *D. schoutendeni* Vuylsteke and Rodhain, 1938

Dirofilaria schoutendeni Vuylsteke and Rodhain, 1938, pp. 357–360, Figs. 1–5

Host: *Colobus polykomos* (Schreber)
Distribution: Africa

17. *D. ursi* Yamaguti, 1941

Dirofilaria ursi Yamaguti, 1941, p. 433, Fig. 1

Host: *Ursus torquatus japonicus* Schlegel
Distribution: Japan

18. *D. tenuis* Chandler, 1942

Dirofilaria tenuis Chandler, 1942, pp. 262–3

Host: *Procyon l. lotor* (L.)
Distribution: United States

SPECIES INQUIRENDAE

Two species connected with the genus *Dirofilaria* are of questionable validity. The history and synonymy associated with them are as follows:

1. *D. striata* (Molin, 1858)

Filaria striata Molin, 1858, pp. 388–9
Solenonema striatum Diesing, 1861, p. 705
Dirofilaria striata (Molin, 1858) Railliet and Henry, 1911, p. 487

Hosts: *Felis concolor* L., *F. macrura* Wied., *Lynx rufus* (Schreber)
Distribution: Brazil

In 1926 several female worms found in the subcutaneous tissue of *Felis pardalis* of Surinam were studied by van Thiel and referred to *Filaria striata* Molin, 1858. Desportes (1940, p. 519) considered that these worms of van Thiel could not be referred to *Dirofilaria*. Molin's (1858) and van Thiel's (1926) material require more study before their identity is certain and the generic placing of both lots of material requires confirmation.

2. *Microfilaria ochmanni* (Fülleborn, 1908)

Filaria ochmanni Fülleborn, 1908, pp. 644–5
Microfilaria ochmanni vide Gedoelst, 1911, p. 107
Dirofilaria ochmanni (Fülleborn) Neumann, 1914, p. 309
Microfilaria ochmanni Fülleborn, 1908, vide Witenberg, 1934, p. 238
Microfilaria ochmanni Gedoelst, 1911, vide Baylis, 1939, p. 5
Filaria ochmanni Fülleborn, 1908, vide Baylis, 1939, p. 5

Host: *Canis familiaris* L.
Distribution: Africa

The combination *Filaria ochmanni* was given by Fülleborn (1908) to microfilariae found in the blood of a dog from Africa. This species was allocated to *Microfilaria* in 1911 by Gedoelst and placed in the genus *Dirofilaria* by Neumann in 1914. Later in 1934 Witenberg listed the combination "*Microfilaria ochmanni* Fülleborn, 1908" as a parasite of the domestic dog in Palestine, apparently in reference to this species. Baylis (1939) placed, with doubt, "*Filaria ochmanni* (Fülleborn, 1908)" and "*Microfilaria ochmanni* Gedoelst, 1911" in the synonymy of *Dirofilaria repens* Railliet and Henry, 1911. In the present paper *Filaria ochmanni* Fülleborn, 1908, *Microfilaria ochmanni* (Fülleborn, 1908), Gedoelst, 1911, and *Dirofilaria ochmanni* (Fülleborn, 1908) Neumann, 1914 are considered correct and synonymous names. There appears to be no record of the adults of the microfilaria described by Fülleborn. Thus the generic placing of this species in other than *Microfilaria* is unwarranted. Moreover, Baylis' synonymy appears to be unacceptable since Fülleborn described his microfilariae as being sheathed whereas those of *D. repens* are unsheathed.

DESCRIPTION OF MALES AND MICROFILARIAE AND REDESCRIPTION OF FEMALES OF *Dirofilaria ursi* YAMAGUTI, 1941

(Figs. 1-18)

DESCRIPTION: Dipetalonematidae Wehr, 1935; Dirofilariinae Wehr, 1935; *Dirofilaria* Railliet and Henry, 1911. Body long and attenuated, gradually increasing in width throughout the first half of body but tapering in the second half. Cuticle with distinct longitudinal ridges and delicate circular grooves which cut across the ridges imparting to the cuticle a "beaded" appearance. Oral opening minute, bounded by a delicate circular membrane. Insignificant cephalic papillae consisting of four pairs of submedial papillae forming an inner and an outer circle radiating from oral opening. Amphids lateral; in line with innermost papillae. Oesophagus usually distinctly divided externally into glandular and muscular portions. Phasmids prominent, occurring ventro-laterally on tip of tail.

Male (30 specimens): Length 51–86 (68) mm.; body width .19–.28 (.24) mm. at nerve ring, .33–.48 (.38) mm. at end of oesophagus, .32–.41 (.37) mm. in middle of body. Anterior end, round and blunt, measuring .12–.17 (.14) mm. wide immediately posterior to the anterior enlargement of the muscular oesophagus. Total length of oesophagus .93–1.5 (1.2) mm.; muscular portion .32–.54 (.44) mm. and glandular portion .57–.93 (.72) mm. long. Muscular oesophagus enlarged anteriorly to a thickness of .040–.072 (.056) mm.; decreasing in thickness in middle regions but enlarging to a thickness of .043–.097 (.068) mm. posteriorly. Glandular oesophagus .079–.13 (.11) mm. wide anteriorly and .094–.15 (.12) mm. posteriorly. Nerve ring .22–.36 (.30) mm. from anterior end Excretory pore minute and located in region of nerve ring. Cuticle with 58–62 branched, longitudinal ridges 14–30(19)μ apart. Caudal end of worm coiled and provided with well-developed caudal alae. Anus .058–.076 (.070) mm. from posterior extremity; body width at anus .081–.12 (.098) mm. Large, pedunculate papillae, which are variable in number and usually arranged asymmetrically, occur ventro-laterally along caudal end of worm. One side usually has more of these large papillae than the other. The first anterior papilla is relatively large, the others gradually decreasing in size. In ten specimens the number of right and left large, ventro-lateral papillae are respectively as follows: 8–7, 10–7, 9–9, 9–9, 8–7, 8–9 (Figs. 1–6), 9–5, 7–9, 8–8, 9–5. The above papillae occurring preanally are respectively as follows: 7–6, 9–6, 8–8, 7–7, 6–6, 7–6, 8–4, 6–7, 7–7, 8–5. Two large oval-shaped, sessile papillae occur immediately behind anus. Smaller pedunculate papillae variable in size, number, position and shape but consisting basically of three pairs arranged in

the form of two triangles occur behind the anus and lateral to the mid-line (Figs. 3, 4). Spicules dissimilar in size and shape; the left measuring .40–.48 (.44) mm. and the right .14–.18 (.16) mm. in length. Proximal third of left spicule consists of a long tube-like shaft (calomus) with an irregular enlargement at proximal end (the head or capitulum). The shaft continues as the blade (lamina) which is separated into two lateral bars by an oval vacuity. Both bars are connected by a flat, transparent plate originating in front of the vacuity and extending distally. The right bar continues caudally as a whip-like structure; the left bar is connected to the main part of the blade by the laterally extending plate mentioned above and decreases in size distally and becomes confluent with the right part of the blade at about two-thirds of the length of the spicule. The right spicule is stout and boat-shaped, tapering to a blunt point from a thicker and rougher proximal base; in ventral view it appears wide and flat with a shallow medial groove on the surface which is open proximally but gradually closed distally as the two edges of the groove come into contact to the right of the mid-line of the spicule. Ratio between the spicules varies from 1:2.5–1:3.1 with a mean ratio of 1:2.8.

Female (30 specimens): Length 117–224 (176) mm.; body width .29–.44 (.34) mm. at nerve ring, .33–.48 (.38) mm. at end of oesophagus, .49–.76 (.61) mm. at position of vulva and .46–.70 (.55) mm. in middle of body. Anterior end, round and blunt, measuring .17–.25 (.21) mm. wide immediately posterior to the anterior enlargement of the muscular oesophagus. Total length oesophagus 1.1–1.6 (1.4) mm.; muscular portion .42–.61 (.52) mm. and glandular portion .65–1.1 (.84) mm. long. Muscular oesophagus enlarged anteriorly to a thickness of .065–.096 (.078) mm., decreasing in thickness in the middle parts but enlarging to a thickness of .055–.11 (.083) mm. posteriorly. Glandular oesophagus .10–.16 (.13) mm. wide anteriorly and .087–.16 (.13) mm. posteriorly. Nerve ring .29–.41 (.35) mm. from anterior end. Excretory pore minute and located in region of nerve ring. Cuticle with 70–72 longitudinal ridges. The vulva, which is conspicuous, is 1.3–3.1 (2.1) mm. from anterior end, and opens into a long vagina the course of which is variable. Two extremes exist; one in which the vagina is directed posteriorly and another in which it is directed anteriorly (Figs. 9–10). The vagina continues into two voluminous uteri at about one-sixteenth of total length of worm. Females ovoviviparous, the eggs occurring in the posterior regions of uteri only. The remainder of the uterus is full of hatched embryos. Caudal end of worm curved dorsally; tail .072–.20 (.13) mm. long; body width at anus .12–.23 (.16) mm.

Microfilaria (15 specimens, Giemsa-stained): Length 185–292 (239)μ and unsheathed; maximum width 4.6–6μ; body width greatest in anterior half of body the posterior half tapering to a delicate tail. Cuticle,

finely striated transversely. Nuclear column composed of about three rows of more or less distinct nuclei most of which are oval-shaped and directed parallel to longitudinal axis of body. A clear space occurs between anterior extremity and nuclear column in which a variously-shaped nucleus or group of nuclei frequently occurs. Relative position of fixed points as follows: nerve ring = 19.6–24.4 (22.0)%; excretory pore = 27.5–34.1 (30.7)%; excretory cell = 30.0–38.0 (34.8)%; first "genital cell" = 59.1–70.5 (64.6)%; anal pore = 71.7–82.5 (78.5)%; last tail cell = 85.5–94.8 (90.2)%. Tail of microfilaria tapers markedly and nuclear column is reduced first to two rows of nuclei and finally to one row of round, irregularly spaced nuclei. Final nucleus often isolated from other nuclei. The remainder of tail usually transparent.

Host: *Ursus a. americanus* Pallas (Type host: *Ursus torquatus japonicus* Schlegel).

Location: Connective tissues, especially those around the cervical and brachial lymph nodes.

Locality: Algonquin Park, Ontario, Canada (type locality: Japan).

Specimens: Parasitology Department, Ontario Research Foundation, Toronto, Ontario.

COMPARISONS AND RELATIONSHIPS

In 1941 Yamaguti described as *Dirofilaria ursi* n. sp. three female worms removed from the abdominal cavity of *Ursus torquatus japonicus*. Measurements of the parasites from Ontario and Japan are remarkably uniform (Table I). Moreover, Yamaguti's description of the anterior end,

TABLE I

COMPARISON OF FEMALE SPECIMENS OF *D. ursi* YAMAGUTI, 1941 from Ontario and Japan

	Ontario	*Japan*
Total length	117–221 mm.	210–220 mm.
Maximum width	.46–.70 mm.	.65–.75 mm.
Width at nerve ring	.29–.44 mm.	.37–.45 mm.
Nerve ring*	.29–.41 mm.	.31–.35 mm.
Length musc. oes.	.42–.61 mm.	.57–.62 mm.
Ant. width musc. oes.	65–96 μ	66–75 μ
Post. width musc. oes.	55–110 μ	70–85 μ
Length gland. oes.	.65–1.1 mm.	.97–1.2 mm.
Ant. width gland. oes.	.10–.16 mm.	.1 mm.
Post. width gland. oes.	.09–.16 mm.	.1–.13 mm.
Tail	.07–.20 mm.	.12–.18 mm.
Vulva*	1.3–3.1 mm.	2.1–2.4 mm.
Embryos	.18–.29 mm. $\times$ 4.5–6 μ	.21–.23 mm. $\times$ 4.5 μ

*Distance from the anterior end.

the form of the vagina and other details are in accord with those of the writer. However, he does not mention the cuticular ridges and transverse grooves which have been found in the Ontario specimens except to say that ". . . . the cuticle is finely striated throughout." It is felt that too much significance cannot be attached to this point of disagreement because of the difficulty in observing these structures and because it is not clear what he means by ". . . striated throughout."

Except for differences in the measurements of the embryos Yamaguti's description would also fit the females of either *D. repens* or *D. subdermata*. Since the females of several species in *Dirofilaria* are similar it is conceivable that the Ontario specimens belong to a different species than that described by Yamaguti. However, since there is close agreement between Yamaguti's data and those of the writer it is proposed that the Japanese and Ontario specimens should be considered to belong to the same species until actual differences of specific value are demonstrated.

Faust (1937) in dividing the genus *Dirofilaria* into two subgenera *Nochtiella* and *Dirofilaria*, noted three distinct morphological characters which serve to distinguish the two subgenera. They are as follows: (1) "Specimens in *Nochtiella* are consistently much smaller. (2) There is a profound bilateral asymmetry in the number and distribution of the caudal papillae of specimens in the subgenus *Nochtiella* whereas there is only slight, although usually appreciable, asymmetry in those structures in the subgenus *Dirofilaria*. (3) The structure of the larger spicule in the subgenus *Nochtiella* is much more acuminate (or even filiform) at its posterior end." *D. ursi* has all the characters of the subgenus *Nochtiella* and it belongs in this subgenus.

Seventeen species, excluding *D. ursi* are at present accommodated by the subgenus *Nochtiella*. These species have a wide host distribution as follows:

PRIMATES—*D. macaca*, *D. corynodes*, *D. schoutendeni*
UNGULATA—*D. acutiuscula*, *D. asymmetrica*, *D. kuelzii*
RODENTIA—*D. bonnei*, *D. subdermata*
LAGOMORPHA—*D. scapiceps*
EDENTATA—*D. incrassata* (also reported from *Nasua* spp.)
CARNIVORA—*D. tenuis*, *D. pagumae*, *D. minor*, *D. granulosa*, *D. sudanensis*, *D. genettae*, *D. repens* (also reported from man).

All these species appear to be distinguishable from *D. ursi*. Four species, *D. subdermata*, *D. acutiuscula*, *D. repens* and *D. genettae* are so similar morphologically to *D. ursi* that careful comparisons between them are required (Table II).

Dirofilaria subdermata

D. subdermata is a common parasite of the porcupine in Ontario and its relationship to *D. ursi* is of particular interest. Boulenger's specimens

TABLE II

COMPARATIVE MEASUREMENTS (IN MMS.) OF *D. ursi* YAMAGUTI, 1941, *D. repens* Railliet and Henry, 1911, *D. acutiuscula* (Molin, 1858), *D. genettae* Baylis, 1928, and *D. subdermata* (MÖNNIG, 1924)

Species	*D. ursi**	*D. repens*	*D. acutiuscula*	*D. genettae*	*D. subdermata***
Author cited		Railliet and Henry, 1911 Lent and Freitas, 1937	Lent and Freitas, 1937	Baylis, 1929	
Male					
Length	51–86 (68)	48-70	30–53	41–49	41–66 (54)
Max. width	.33–.48 (.38)	.37–.45	.27–.34	.3–.32	.28–.42 (.36)
Length oes.	.93–1.5 (1.2)		1.3–1.7	.85	.97–1.4 (1.2)
Length tail	.058–.076 (.070)	.066–.085	.1	.06	.062–.081 (.071)
R. preanal papillae	6–9	2–6	4–7	4	5–7
L. preanal papillae	4–8	4–5	4–7	4	5–7
Left spicule	.40–.48 (.44)	.43–.59	.35–.62	.49	.29–.47 (.40)
Right spicule	.14–.18 (.16)	.18–.21	.13–.24	.18–.19	.12–.16 (.15)
Ratio spicules	1:2.8	1:2.5	1:2.6	1:2.6	1:2.8
Female					
Length	117–224 (176)	100–170	85–120	110–115	117–185 (150)
Max. width	.46–.70 (.55)	.46–.65	.50–.53	.4–.43	.44–.67 (.54)
Vulva***	1.3–3.1 (2.1)	1.5–1.9	1.5–2.3	1.8–2.1	1.6–2.4 (1.9)
Length tail	.072–.20 (.13)	.055–.090	.112	.06–.07	.086–.19 (.15)
Length oes.	1.1–1.6 (1.4)	1.0–1.5			1.1–1.6 (1.4)
Microfilaria					
length	.185–.292 (.239)	.300–.360	.288		.245–.276 (.261)
max. width	4.6–6 μ	6.5–8 μ	5 μ		4–6 μ

*Based on a study of 30 male and 30 female specimens from some 20 black bears.
**Based on a study of 23 male and 14 female specimens from 4 porcupines.
***Distance from anterior end.

have not been available to the writer and Canavan's material has not been located. However the data given by Linstow (1899), Boulenger (1920) and Canavan (1929) agree so closely with that obtained on examination of the filariids of Ontario porcupines that there seems little doubt that we are dealing with the same species. Every measurement given by these authors falls within the ranges found in the Ontario specimens from the porcupine, Boulenger, however, describes the oesophagus as "... not divided into anterior and posterior regions" whereas Canavan notes when proposing *D. spinosa* that the oesphagus is clearly divided into two portions in his specimens. However an examination of the Ontario specimens in both the bear and the porcupine shows that there is often a minority of preserved specimens which do not show this division clearly. Boulenger describes the cuticle as appearing ". . . . smooth

except under high magnifications when a fine transverse striation is apparent." Under the coverslip and surrounded by clearing medium the cuticle of the Ontario nematode has this appearance although in places where the cuticle is free of clearing medium distinct ridges which are cut transversely by circular grooves can be seen (the presence of these ridges has been confirmed by cross-sectioning (Fig. 19)). Canavan does not describe the cuticle. Boulenger states that there are ". . . four submedian papillae" whereas Canavan states that there are ". . . six papillae around the simple mouth opening: two lateral, and four submedian." The Ontario specimens have four pairs of submedial papillae and two lateral amphids (Fig. 21). The Ontario specimens agree morphologically in all other particulars with the descriptions of the earlier authors and it is assumed that we are dealing with the same species.

A comparison of the filariids from the bear and the porcupine shows that these two species are morphologically very similar. The females of these two species appear to be indistinguishable morphologically, a feature common to other species of *Dirofilaria*. Plimmer (1915) reported the occurrence of microfilariae in the blood of the porcupine but he did not describe them. Highby (1943) clearly distinguished the microfilariae of *D. subdermata* from those of *Dipetalonema arbuta* Highby, 1943, by three features:—"*Mf. arbuta* has a cephalic space which is longer than its width while that of *Mf. spinosa* is shorter than its width; the terminal nuclei at the posterior end of the nuclear column of *Mf. arbuta* present a more scattered appearance than the more compact arrangement seen in *Mf. spinosa*; and in *Mf. arbuta* an 'Innen Körper' is present, but none is apparent in *Mf. spinosa*." There appears to be no description of *Mf. subdermata* in the literature other than that given by Highby. Ten alcohol-fixed, Giemsa-stained microfilariae from the porcupine were examined and they measured as follows: length = 245–276 (261)μ; nerve ring = 18.1–20.9 (19.0)%; excretory pore = 26.2–32.6 (28.6)%; excretory cell = 30.1–34.5 (32.8)%; first "genital cell" = 59.0–64.9 (62.8)%; anal pore = 72.5–78.4 (75.6)%; last tail cell = 85.8–92.7 (88.5)%. In one specimen the remaining "genital cells" are well differentiated and the relative position of these cells is as follows: G2 = 60.8%; G3 = 67.7%; G4 = 71.6%. In 5 drops of blood in 5 cc. of 5% formalin 10 microfilariae measured 284–304 (295)μ in length. These data do not depart significantly from those of microfilariae from the bear.

The caudal end of ten male worms from the porcupine were examined in ventral view and the number of papillae and their arrangement were compared with similar views of the caudal end of ten male specimens from the bear (examples: Figs. 1–6). Below are listed the results of counting the large ventro-lateral, caudal papillae, the total number on the right side preceding those on the left.

D. ursi: 8–7, 10–7, 9–9, 9–9, 8–7, 8–9 (Figs. 1–6), 9–5, 7–9, 8–8, 9–5 (Av. = 8.5–7.5).
D. subdermata: 7–6, 6–7, 8–6, 6–8, 6–6, 6–6, 7–7, 6–7, 7–7, 7–6 (Av. = 6.6–6.5).

Those of the above ventro-lateral papillae which occur preanally are as follows:

D. ursi: 7–6, 9–6, 8–8, 7–7, 6–6, 7–6, 8–4, 6–7, 7–7, 8–5 (Av. = 7.3–6.2).
D. subdermata: 5–5, 5–6, 7–6, 5–7, 5–5, 5–5, 6–6, 5–6, 5–5, 6–6 (Av. = 5.4–5.7).

Although the papillae characteristics of the two species overlap, the data indicate that the bear worm has significantly more of the larger caudal papillae than *D. subdermata*. There is, moreover, a pronounced tendency towards symmetry in the number and arrangement of the larger caudal papillae in *D. subdermata* which is not so pronounced in *D. ursi*.

Except for the large, sessile, oval-shaped pair of papillae immediately behind the anus the number and arrangement of the smaller postanal papillae are highly variable in both species. A similar basic pattern seems to exist in both however.

Although overall differences may exist in the lengths of the males the writer has not been able to find any other differences between these two species.

Dirofilaria acutiuscula

This species is apparently a smaller species than *D. ursi*. Lent and Freitas (1937), who have studied a series of specimens of *D. acutiuscula*, give the male size as 30–53 × .27–.34 mm. and the female size as 85–120 × .50–.53 mm. whereas the comparative measurements found in *D. ursi* are respectively 51–86 × .33–.48 mm. and 117–224 × .46–.70 mm.

Lent and Freitas illustrated the caudal end of 13 male specimens of *D. acutiuscula*. In comparing these illustrations with those of *D. ursi* one is immediately struck by the fact that the papillae of the Brazilian species appear to be much more variable in position and number than those of *D. ursi*. Like *D. ursi* this species has numerous large caudal papillae of which 4–7 are preanally located, but the disposition and the shape (with some exceptions) of these papillae do not conform to those found in *D. ursi*. Firstly, they are irregularly spaced, a characteristic which has not been found in *D. ursi*, and secondly they appear to be longer and narrower. The writer has confirmed the arrangement observed by the Brazilian authors by examining a male specimen of *D. acutiuscula* (No. 8942—Collection Helminths, Institute of Ozwaldo Cruz). Moreover, in only four of the thirteen illustrations by Lent and Freitas are there

shown a pair of sessile papillae immediately behind the anus to compare with those found in all the specimens of *D. ursi* (and incidentally, *D. subdermata*) that were examined. The remainder of the postanal papillae are more variable in position and number than those found in *D. ursi* although Lent and Freitas illustrate a specimen (pl. 7, figs. 2–3) which has a papillae pattern similar to that found to be basic for *D. ursi* (and *D. subdermata* and possibly for *D. repens*).

Until these apparent differences in body size and papillae are resolved the writer is inclined to regard *D. ursi* and *D. acutiuscula* as distinct species. There are other features of *D. acutiuscula* which require clarification, e.g. oral papillae.

Dirofilaria repens

D. repens is reported (Railliet and Henry, 1911; Vogel, 1927 and Lent and Freitas, 1937) to have 2–6 right preanal papillae and 4–5 left preanal papillae. The number of preanal papillae possessed by the three male specimens of *D. repens* examined by the writer (U.S.N.M. No. 7508) falls within that given by the above authors. *D. ursi* apparently has on the whole more preanal papillae than are reported for *D. repens*. The pattern of the smaller postanal papillae of *D. repens* is remarkably similar, however, to that of both *D. ursi* and *D. subdermata* (see Vogel, 1927, for illustration of caudal end of *D. repens*).

The length of the right spicule of *D. repens* is usually given as .18–.21 mm. (Railliet and Henry, 1911; Lent and Freitas, 1937 *et al.*) although Vogel (1927) gave a range of .19–.20 mm. and Bhalerao (1935) a range of .185–.206 mm. The writer has measured the right spicules of two male specimens from the United States National Museum (No. 7508) and estimates them to be .14– and .15 mm. long. Both specimens appear to be mature measuring respectively 49 mm. and 54 mm. in total length. This would suggest that the right spicule of *D. repens* may occasionally be much shorter than has hitherto been reported. Since the right spicule of *D. ursi* measures .14–.18 (.16) mm. long it is at present questionable if this species can be distinguished from *D. repens* on the basis of the length of the right spicule even though the data in the literature would indicate that it is possible. It is perhaps worthy of note that if the right spicule of *D. repens* consistently falls shorter than is usually given, the status of *D. subdermata* may require clarification as the latter species can apparently only be distinguished from *D. repens* at the present time in having a shorter right spicule, i.e., below .18–.21 mm.

The length of the microfilaria of *D. repens* is given as 300–360μ by Railliet and Henry (1911) and Lent and Freitas (1937); 312–318μ by Mazza and Romana (1932); 337.2–379.7 (353)μ by Dhayagude (1943) and .207–.360 × .005–.008 mm. by Bhalerao (1935). The methods

used by these authors in preparing the specimens for examination is not known. Fülleborn (1913) found great variability in the length of *Mf. repens* depending on the method used in preparing the specimens for examination. He gives the total length as 267.5–309.0 (283.7)μ in specimens fixed in hot alcohol and stained with haematoxylin. The length of *Mf. ursi* on alcohol-fixed Giemsa-stained smears has been found to be 185–292 (239)μ which is below that reported for *Mf. repens*.

At the present time there seems to be sufficient reason for regarding *D. ursi* as morphologically distinct from *D. repens*. There appears to be a need for an examination of a large series of specimens of *D. repens* to determine the extent of the variability exhibited by this species.

Dirofilaria genettae

According to Baylis (1928) this species is distinct from *D. repens* in that "... it is rather smaller and more slender" and "... the vulva is situated rather further from the anterior end and the number and arrangement of the caudal papillae are different from those described by Railliet and Henry (1911)." Unfortunately Baylis did not describe the disposition of the caudal papillae and he illustrated a lateral view of the caudal region only. The disposition of the caudal papillae, size of the body and the position of the vulva have been found to be extremely variable in *D. ursi*, *D. subdermata* and *D. acutiuscula* (see Lent and Freitas, 1937) and the data given by Baylis do not depart sufficiently from those reported for *D. repens*. *D. ursi* seems to be distinct from *D. genettae* on the same grounds as it is distinct from *D. repens*, i.e., number of caudal papillae and the length of the right spicule (?). *D. genettae* requires more study and its relationship to *D. repens* requires clarification.

Cuticular Markings in Dirofilaria

The similarity of the cuticular markings found in several species of the subgenus *Nochtiella* is of interest. Chandler (1942) pointed out that the cuticle of most of the species in *Dirofilaria* has not been carefully described and he suggested that the cuticular markings may offer specific characters in this genus. The writer has found longitudinal markings on the cuticle of *D. ursi* which are best described as ridges (Figs. 15–18). Fine transverse striations cut across these ridges imparting to the cuticle a beaded appearance. Similar structures occur on the cuticle of the specimens of *D. repens*, *D. subdermata* (Fig. 19) and *D. acutiuscula* examined by the writer. Lent and Freitas, 1937, first reported these structures in the latter species, referring to them as longitudinal ridges. There appears to be little or no difference between these species in the number and structure of the longitudinal ridges. Chandler (1942) describes the cuticle of *D. tenuis* as possessing "... about 90 ridges, conspicuously

broken and branched and spaced only about 10μ apart." *D. immitis*, although possessing the transverse striations which appear to be of general occurrence in the genus *Dirofilaria*, lacks longitudinal ridges (Fig. 20). This important anatomical difference between *D. immitis*, type of the subgenus *Dirofilaria*, and several species in the subgenus *Nochtiella*, including the type *D. repens* is noteworthy. It is conceivable, when the cuticle of all the species has been adequately described, that it may be possible to group the species in *Dirofilaria* according to the presence or absence of longitudinal ridges. It is also possible that such groups may coincide with the existing subgeneric arrangement of Faust. The cuticular ridges observed by the writer on the cuticle of several species in *Nochtiella* are difficult to see if the specimens under observation are completely covered with clearing medium, but they show up well in places where the medium has drained from the cuticle surface. This phenomenon may account for the fact that they have not been reported hitherto for *D. subdermata* and possibly other species although these ridges, if present, are easily observed in cross-sections of the worms.

SUMMARY

A large collection of filarioid worms, found in the subcutaneous tissues of all the black bears (*Ursus a. americanus*) examined from Algonquin Park, Ontario, have been studied and referred to *Dirofilaria ursi* Yamaguti, 1941. The males and microfilariae of this species are described for the first time and the females are redescribed more fully. *D. ursi* has been compared with all the other members of the genus and found to be distinct. It is morphologically similar however, to *D. repens* Railliet and Henry, 1911, *D. acutiuscula* (Molin, 1858), *D. genettae* Baylis, 1928, and *D. subdermata* (Mönnig, 1924) and therefore it is compared with these species in detail.

The genus *Dirofilaria* Railliet and Henry, 1911, is reviewed and found to consist of 23 apparently valid species and one species of questionable validity. *D. spirocauda* (Leidy, 1855) *sub judice* Faust, 1937, is considered to be a synonym of *D. immitis* (Leidy, 1856) and *D. conjunctivae* (Addario, 1885) Desportes 1940 a synonym of *D. repens* (see Skrjabin, 1947). The correct citation for the species of *Dirofilaria* occurring in *Cephalophus maxwelli* Smith is given as *D. kuelzii* (Rodenwaldt, 1910) Seurat, 1916. The name usually given to the species occurring in the porcupine, *D. spinosa* Canavan, 1929, is changed to *D. subdermata* (Mönnig, 1924) Canavan, 1929. *D. striata* (Molin, 1858) Railliet and Henry, 1911, is considered to be a *species inquirendae*. Following Gedoelst (1911) *D. ochmanni* (Fülleborn, 1908) Neumann, 1914 is allocated to *Microfilaria*. *D. websteri* (Cobbold, 1879) Yorke and Maplestone, 1926, and *D.* (?) *digitata* Chandler, 1929, are not considered to be members of *Dirofilaria* (see Johnson and Mawson, 1938, and Desportes, 1940).

ACKNOWLEDGMENTS

The writer is pleased to acknowledge the assistance which he has received from Dr. A. M. Fallis, Professor of Parasitology and Dr. J. F. A. Sprent, Assistant Professor of Parasitology who supervised the work. The writer is particularly grateful to Dr. H. B. Speakman, Director of the Ontario Research Foundation for facilities at the Foundation, and for encouragement and helpful suggestions throughout the course of the work. Several individuals collected the nematodes studied herein, notably, Mr. C. D. Fowle, Dr. D. M. Davies and Mr. G. Bennett and the writer is grateful for the opportunity to examine these specimens. I am indebted also to the various members of the staff in the Zoology Department, University of Toronto, for their advice and assistance. Finally, I would like to acknowledge my indebtedness to the Library Staff of the Ontario Research Foundation for their co-operation, without which this study would have been impossible.

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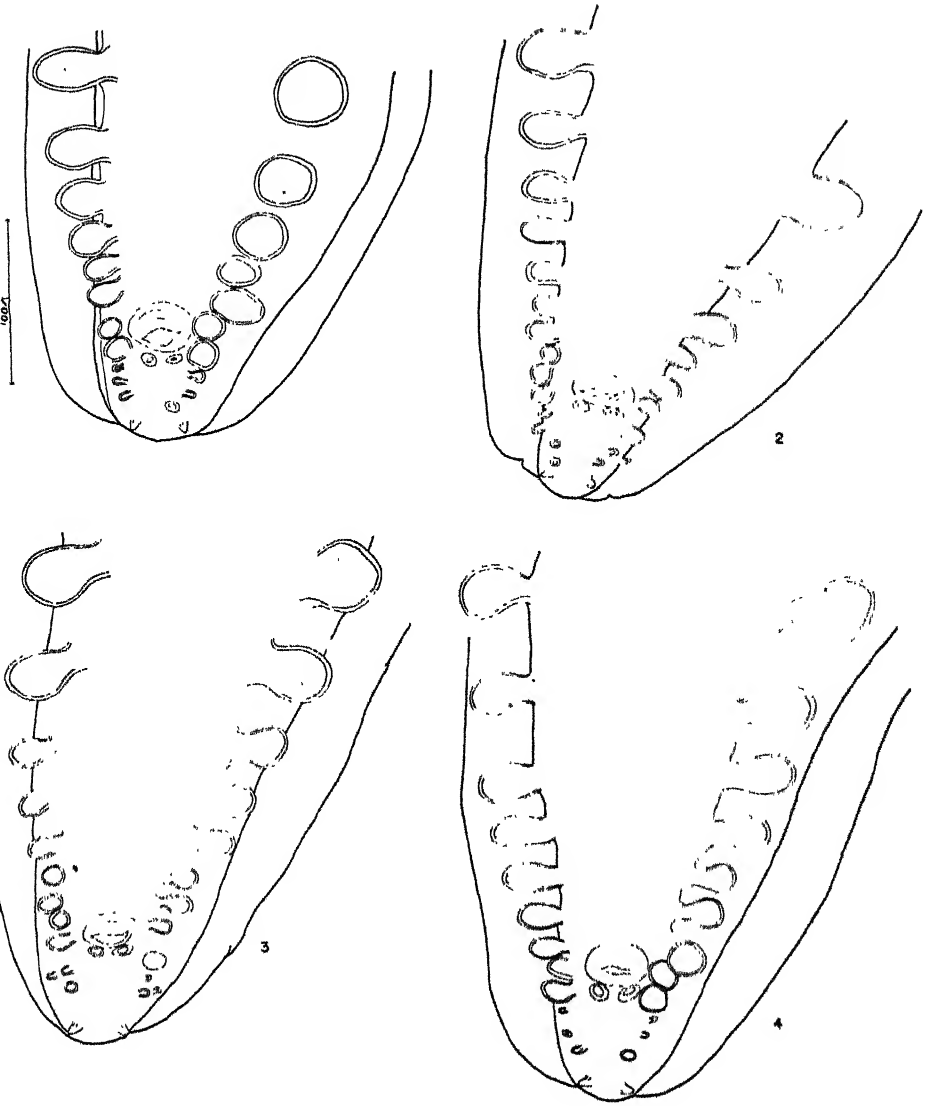
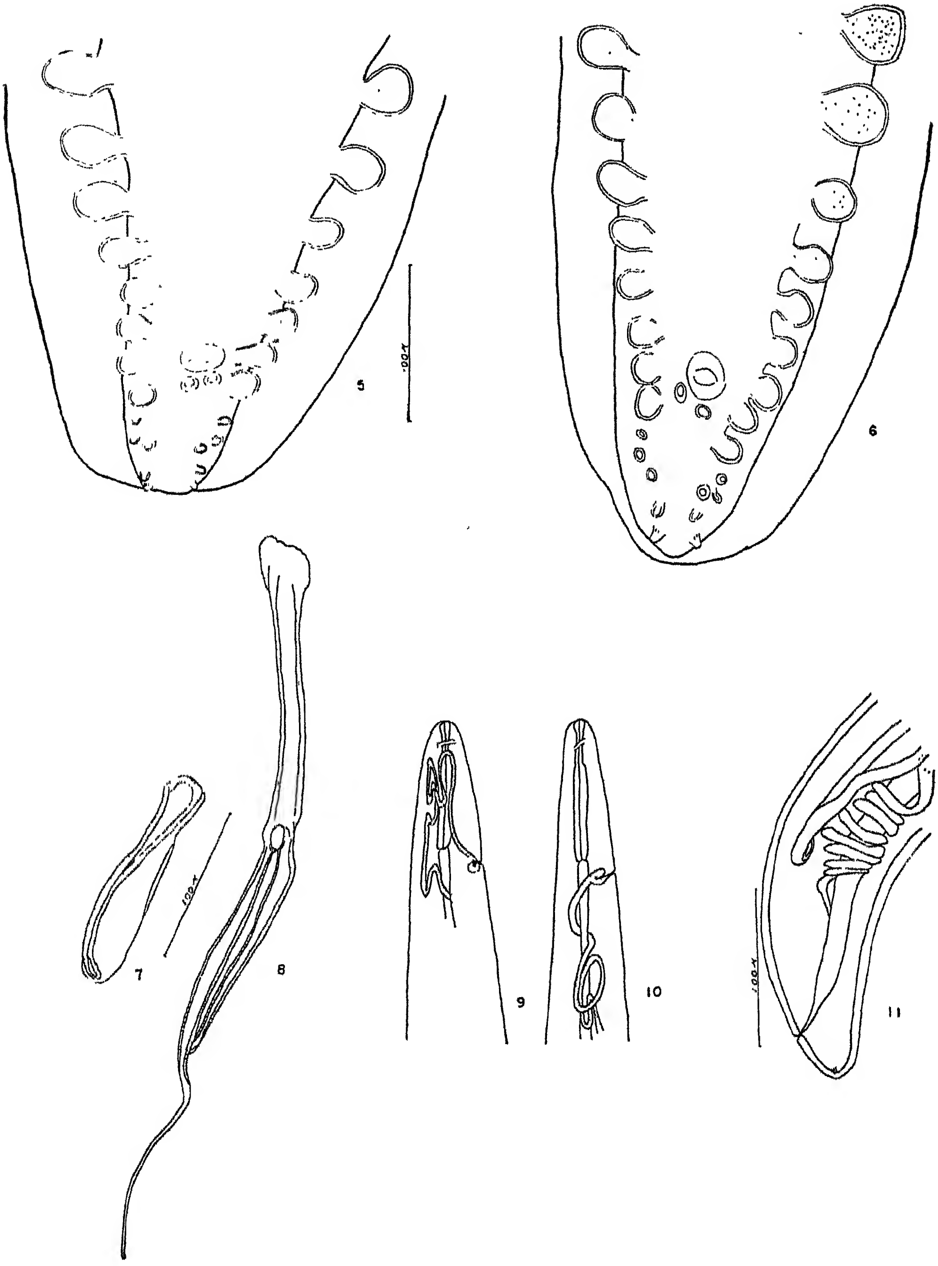


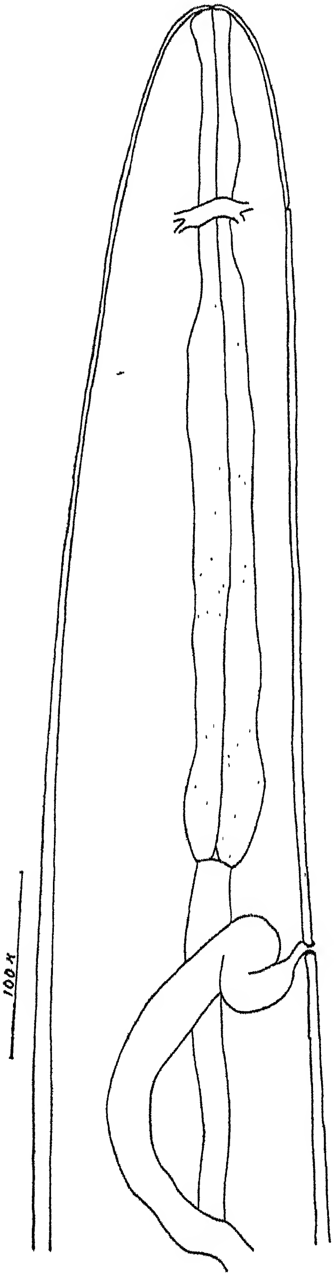
Dirofilaria ursi Yamaguti, 1941

FIGS. 1-4. Caudal ends males. Ventral view. (All drawn to the same scale with the aid of a camera lucida.)



Dirofilaria ursi Yamaguti, 1941

FIGS. 5-6. Caudal ends males. Ventral view. FIG. 7. Right spicule. Ventral view. FIG. 8 Left spicule. Ventral view. FIGS. 9-10. Lateral views of females showing course of vagina in extreme cases. FIG. 11. Caudal end female. Left-lateral view. (All drawn with aid of camera lucida.)



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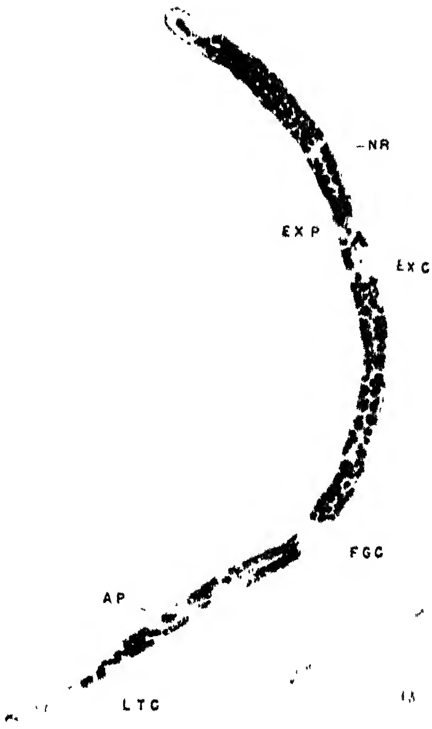

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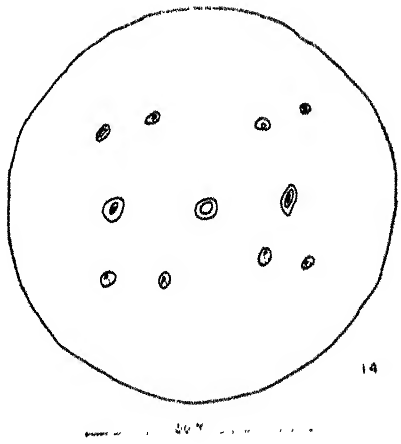

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Dirofilaria ursi Yamaguti, 1941

FIG. 12. Anterior end female. Right-lateral view. FIG. 13. Microfilaria. Left-lateral view. FIG. 14. *En face* view of female showing oral papillae and amphids.

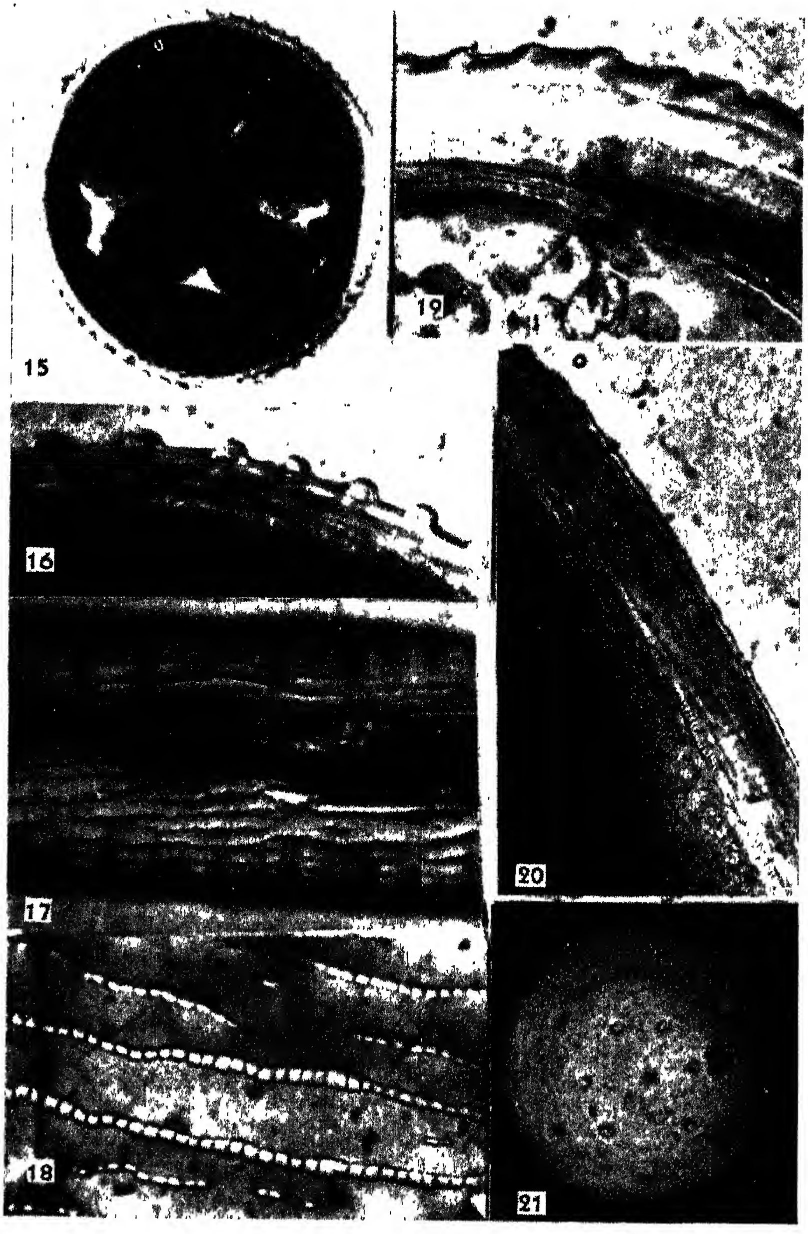

FIG. 15. Cross-section through body of female *D. ursi* showing longitudinal ridges on cuticle x 100. FIG. 16. High-power of Fig. 15 x 400. FIG 17. Surface view of cuticle of *D. ursi* showing longitudinal ridges cut by transverse grooves x 100. FIG. 18. High-power of Fig. 17 x 400. FIG. 19. Cross-section through body of *D. subdermata* showing longitudinal ridges on cuticle x 400. FIG. 20. Cross-section through body of *D. immitis* x 400. Fig. 21. *En face* view of female *D. subdermata* x 200.

THE DISTRIBUTION OF SOME TREES AND SHRUBS OF THE CAROLINIAN ZONE OF SOUTHERN ONTARIO

PART I

W. SHERWOOD FOX[1] AND JAMES H. SOPER[2]

INTRODUCTION

Early French explorers in what is now southern Ontario (Fig. 1), especially the region between the Niagara and the Detroit rivers, noted with amazement the character of the flora. In variety and lushness it seemed to belong to a much warmer climate. Among those who commented upon the subject were the Sulpician, Bréhant de Galinée, and the garrulous but keen-eyed Baron de Lahontan. European botanists,

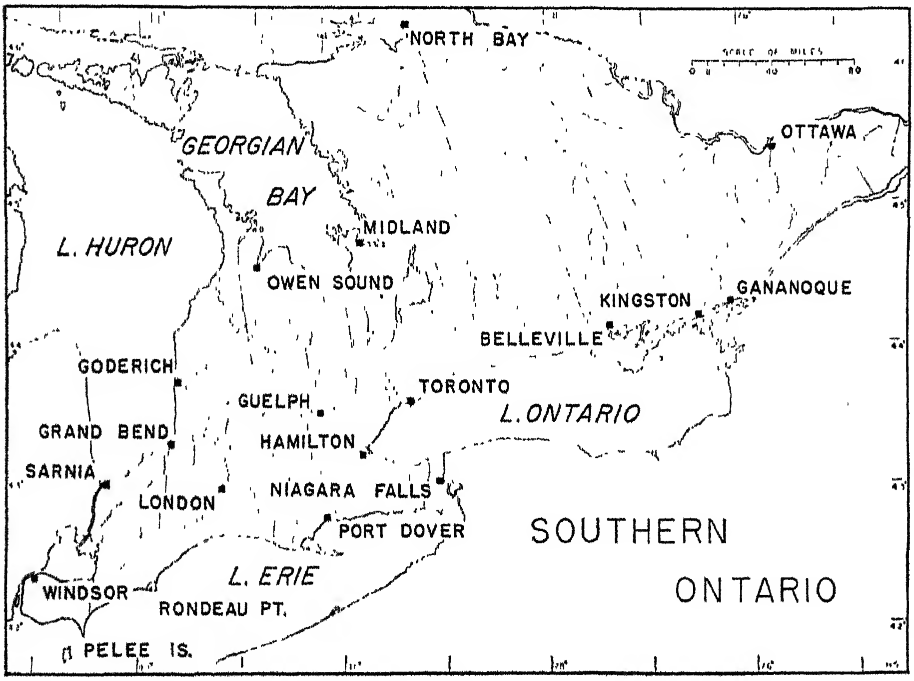

FIG. 1. Map of Southern Ontario.

such as Kalm and Rafinesque, who came to North America in the middle decades of the eighteenth century, noted the phenomenon, but since the continent was still under a single sovereignty had no occasion to relate their observations to a political boundary. The creation of the United

[1]Former President of the University of Western Ontario, London.

[2]Assistant Professor of Botany and Curator of the Herbarium of Vascular Plants, University of Toronto, Toronto.

States offered a new point of view: when, in the last years before 1800 and the first decades immediately following, travellers from that country passed through the southern part of Upper Canada, they were very conscious of having crossed a frontier. This fact explains remarks, both specific and casual, in their records, to the effect that the flora of the Canadian peninsula, especially such conspicuous forms as trees and shrubs, was about the same as the flora of their own country south of the Great Lakes. A little later, British botanists—e.g. John Goldie in 1818 and David Douglas in 1823—in exploring tours on both sides of the international line noticed and recorded the similarity.

Little by little it dawned upon studious observers that in stressing this similarity as being between two countries they were failing to perceive the important element of a significant phenomenon. As viewed by science, the division of the territory between two sovereignties was purely fortuitous; what mattered was that, despite the interposition of a formal frontier and the broad span of inland seas, the territory under observation was a unit. From its northern limit, somewhere in Canada, it stretched into the southland as far as Tennessee and the Carolinas, and even beyond. It even reached out westward and southwestward across the Mississippi. Captivated by a name redolent of the South, one investigator called, quite appropriately, the vast, roughly-defined expanse, the Carolinian Zone. Others, with an eye to climate rather than to geography, expressed a preference for the term Subaustral, a designation recalling the Roman Auster, the hot, parching wind that blew across the Mediterranean from Africa. A Subaustral zone, then, is, literally, a tract that borders on a territory of great heat.

At this stage a major question confronts us: Where shall one draw the northern boundary line of this enormous zone? Even the position of the Canadian portion of this boundary has not been agreed upon by botanists in the past. We trust that this study will help to provide the answer to this question with regard to Ontario. Manifestly, it can be found only through the most painstaking scrutiny of a multitude of plants and of the distribution of their stations. It is by design that the present study has been limited to only a part of the whole series of species subject to review: the Carolinian trees and shrubs form a group large enough to be representative, small enough to escape being unwieldy, and made up of species conspicuous enough to be singled out readily in a landscape. The endeavour to determine the Canadian limit of the Carolinian Zone is not new, though we believe the manner of approach may be.

The advance of a Carolinian flora into Ontario is more than merely a modern wonder. During the long interglacial period of the Pleistocene the Zone extended north of Toronto for probably a considerable distance.

In his account of that era, the late Professor A. P. Coleman (5) set forth evidences that support that conclusion. These have been brought to light deep down beneath the valley of the Don River at Toronto. They appear chiefly in the form of imprints of leaves in the interglacial shales exposed in the pits excavated by the brickworks. Some of the trees and herbaceous plants to which the leaves belong are species now present in the Canadian strip of the Carolinian Zone. These and other remains, such as fragments of wood, seem to have been borne to their present beds by a great river that flowed south from the northern hinterland into a lake that preceded Lake Ontario. "It is agreed by botanists and foresters," says Coleman, "that the interglacial forest indicates a climate of 4° to 5° warmer than at present, about like that of Ohio and Pennsylvania" (op. cit., p. 76).

Among the Carolinian trees that have left traces at Toronto and are now native to southern Ontario Coleman lists: *Asimina triloba* (Pawpaw); *Fraxinus quadrangulata* (Blue Ash); *Hicoria* (*Carya*) *ovata* (a sweet Hickory); *Juniperus virginiana* (Red Cedar); *Platanus occidentalis* (Sycamore, Plane-Tree); *Quercus alba* (White Oak); *Q. Muehlenbergii* (Chestnut Oak); *Castanea dentata* (Sweet or Edible Chestnut). The immense age of these trees may be deduced from a terse observation in THE LAST MILLION YEARS: "It is estimated . . . that the ice of the last glacial period left the Ontario region 25,000 or 30,000 years ago. The interglacial period cannot have been less than three times as long and probably was six times as long, say 150,000 or 300,000 years" (op. cit., p. 83).

The data and maps which follow cover ten species selected from a large list considered characteristic of the Carolinian Zone by one or more of the previous students of the Canadian flora. It is hoped that similar detailed information which is now being collected for other species will be presented in a later paper. Discussion and conclusions regarding the distribution of the species in this zone will be withheld for the concluding part of this paper that will be published later. The following are the species to be discussed in this first paper:

1. *Magnolia acuminata* L.	MAGNOLIACEAE
2. *Liriodendron Tulipifera* L.	MAGNOLIACEAE
3. *Asimina triloba* (L.) Dunal	ANNONACEAE
4. *Sassafras albidum* (Nutt.) Nees	LAURACEAE
5. *Lindera Benzoin* (L.) Blume	LAURACEAE
6. *Platanus occidentalis* L.	PLATANACEAE
7. *Xanthoxylum americanum* Mill.	RUTACEAE
8. *Ptelea trifoliata* L.	RUTACEAE
9. *Staphylea trifolia* L.	STAPHYLEACEAE
10. *Cornus florida* L.	CORNACEAE

SYMBOLS AND ABBREVIATIONS

Four types of symbols have been used to distinguish the different kinds of records on the maps. The locations of collection of specimens examined in the herbarium are shown as black dots; those for plants examined, but not collected, by either author in the field - as open circles; published reports considered authentic - as solid triangles; and other records such as personal communications, both oral and written, from other collectors, when the information seemed credible on the basis of the known distribution - as open triangles.

The following are the abbreviations used to designate the herbaria[3] from which specimens were examined: CAN National Museum of Canada, Ottawa, Ontario; DAO Division of Botany, Department of Agriculture, Ottawa, Ontario; GH Gray Herbarium of Harvard University, Cambridge, Massachusetts; JFC Herbarium of J. F. Calvert, London, Ontario; McM -McMaster University, Hamilton, Ontario; McMHA-- Herbaıium of Hamilton Association at McMaster University; MDK -Herbarium of M.D. Kirk, Lindsay, Ontario; ML -Herbarium of Monroe Landon, Simcoe, Ontario; MT- -Herbier Marie-Victorin, Institut Botanique, Université de Montréal, Montreal, Quebec; OAC -- Ontario Agricultural College, Guelph, Ontario; QU Queen's University, Kingston, Ontario; RFC Herbarium of R. F. Cain, Department of Botany, University of Toronto, Toronto, Ontario; TRT -Department of Botany, University of Toronto, Toronto, Ontario; WO University of Western Ontario, London, Ontario. Other abbreviations include: corr. = in correspondence with; s.n. = sine numero, i.e. without collector's number; s.r. = sight record, i.e. a record of a plant for which no specimen was preserved; Tp. = township; Is. = island; conc. = concession.

DISCUSSION OF SPECIES

MAGNOLIACEAE--Magnolia Family

1. *Magnolia acuminata* L. - CUCUMBER-TREE, MOUNTAIN OF POINTED-LEAVED MAGNOLIA, INDIAN BITTER.

The mere fact that a true Magnolia, though very rare and now restricted to two extremely limited areas, appears among Canada's indigenous plants, sharply forces one to realize that Canada is not as northern a land as popular belief holds her to be. The Cucumber-Tree is found in Ontario as a native tree on good forest soils in Lincoln and Welland counties and on sandy soil in Norfolk county. It has been planted in

[3]The abbreviations for herbaria have been taken from Lanjouw & Stafleu (10) when given in the publication. For the herbaria not listed there, tentative abbreviations have been assigned, some of which are in general use.

many places, e.g. in the counties of Middlesex, Perth, Prince Edward, Simcoe, Wellington, and York. In most or all of these regions, although somewhat north of its natural area, it grows well and flowers freely. One may see planted specimens in parks and private grounds here and there in southern Ontario, e.g. in Alliston, Fort Erie, Guelph, Hamilton, Leaside, London, Niagara Falls, St. Mary's, Toronto, Weston, and doubtless elsewhere also.

The distribution of the known indigenous stands is shown on map 1, Fig. 2, and a list of specimens arranged by counties follows:

LAMBTON: Formerly in the dunes by the Lost Lakes between Port Franks and Ipperwash but now believed to be extinct there—a large tree, since cut down, was reported to W. S. Fox some years ago by Mr. Tom Hill and a Mr. Hessel. LINCOLN: Near St. Catharines, June 10, 1897, *W. C. McCalla* (CAN). NORFOLK: Turkey Point, June 4, 1934, *J. J. Stroud* (TRT); Walsh P.O., Sept. 4, 1932, *H. H. Brown* (TRT); lot 12, conc. VIII, Charlotteville Tp., June 13, 1948, *M. Landon* (McM); outskirts of Lynedoch, about Sept. 30, 1904, *A. C. Campbell* (CAN). WELLAND: Fenwick, Sept. 23, 1948, *Bert Miller 774* (McM); lot 15, conc. VIII, Pelham Tp., about 3½ miles west of Fonthill, July 5, 1950, *Soper et al 4901* (TRT); formerly near Niagara Falls but now represented there only by planted specimens.

The Cucumber-Tree was reported by the Abbé Provancher in his FLORE CANADIENNE in 1862 (13) with the distribution given as

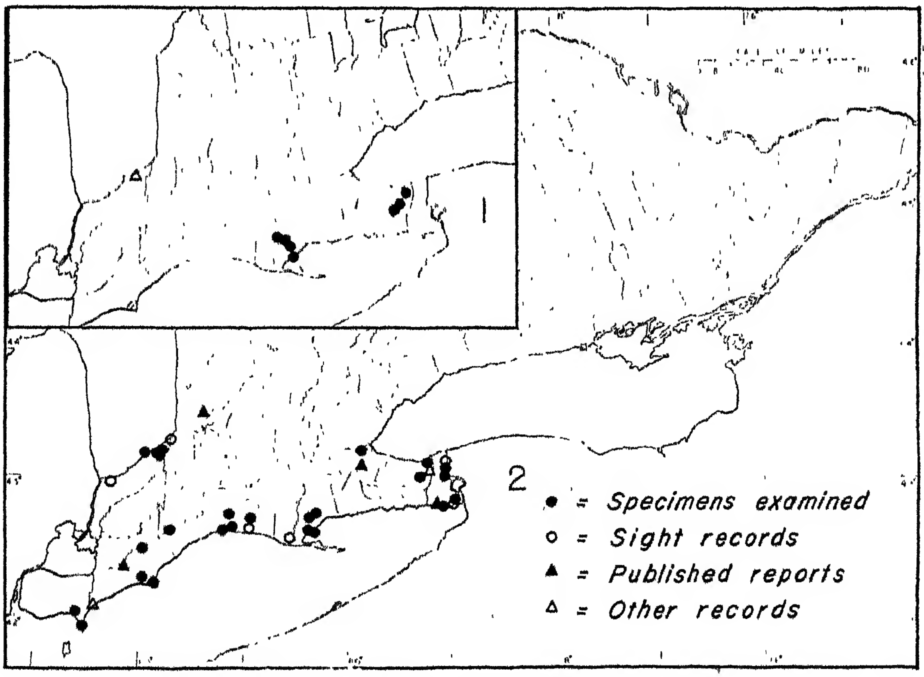

FIG. 2. Distribution of native MAGNOLIACEAE:
(1) Cucumber-Tree (*Magnolia acuminata*).
(2) Tulip-Tree (*Liriodendron Tulipifera*).

"Canada—Géorgie; Près de la chute de Niagara! Mai." It was also included in a list of indigenous plants of Queen Victoria Park by R. Cameron in 1895 (3). At the present time, however, no trees are known in the Niagara Falls area which could be considered indigenous, according to George H. Hamilton of the Niagara Parks Commission.[4]

2. *Liriodendron Tulipifera* L.—TULIP-TREE, TULIP OF YELLOW POPLAR, POPPLE, WHITEWOOD.

This stately, beautiful tree, also a member of the Magnolia family, is evenly, though somewhat sparsely, distributed over southern Ontario. It grows on a variety of soils, from moist lowland of sand-swampy types to well-drained sandy tracts. The densest stand of the species perhaps is in the long interdunal swampy trough stretching behind the line of sand dunes and beach from the village of Port Franks to Kettle Point in Lambton County. In 1875 Gibson and Macoun (8) reported the Tulip-Tree to be native as far north as the valley of the Bayfield River. Today the most northerly recorded living specimen thought to be indigenous is the large, obviously wild tree growing just north of Grand Bend (see note below under Huron Co.).

The location of the known indigenous stands in southern Ontario is shown on map 2, Fig. 2, and the following list provides the basis of the records plotted on the map.

ELGIN: Aylmer, June 30, 1898, *R. T. Anderson* (TRT); Port Stanley, July, 1921, *C. R. Twinn* (OAC); near St. Thomas, July 3, 1907, *J. Macoun* (CAN); lot 12, conc. II, Yarmouth Tp., about 3 miles southeast of Union, July 18, 1941, *J. H. Soper 2725* (TRT); on south side of road leading from Copenhagen to Port Bruce, *W. S. Fox* (s.r.). ESSEX: Near Leamington, June 30, 1882, *J. Macoun* (CAN); Point Pelee, June 11, 1916, *M. O. Malte* (CAN). HURON: [without exact locality], June 30, 1928, *J. A. Fraser* (TRT); a large tree with a double trunk is growing on the property of Colonel Ibbotson Leonard in the extreme north part of Oakwood, Grand Bend, in a sand dune not two hundred feet from the shore of Lake Huron; "throughout the Western peninsula of Ontario, from Hamilton to the township of Tuckersmith, Huron Co. (*Gibson*)"—Macoun (12). KENT: Blenheim, Aug. 9, 1886, *T. J. W. Burgess* (DAO); Rondeau Provincial Park, Aug. 15, 1940, *J. H. Soper* 2382 (GH); lot 7, river range, Howard Tp., about 3 miles southwest of Thamesville, June 24, 1950, *Soper & Shields 4791* (TRT); near Chatham, Logie (11); near Wheatley, *J. Leader* (corr. WSF). LAMBTON: Kettle Point, Lake Huron, July 21, 1940, *Soper & Burcher 2275* (DAO, McM); about 12 miles south of Grand Bend, July 18, 1940, *Soper & Burcher 2205* (DAO, McM); Port Franks, July 21, 1932, *L. O. Gaiser* (McM); between Port Franks and Thedford, Oct. 15, 1879 [without collector] (DAO); along the Blue Water Highway for 6 miles east and north of Sarnia, *W. S. Fox* (s.r.). LINCOLN: St. Catharines, June 16, 1897, *W. C. McCalla* (CAN); in Niagara Tp., about 2½ miles northeast of St. Davids, July 25, 1941, *J. H. Soper* (s.r.). MIDDLESEX: ½ mile northeast of Wardsville, July 22, 1948, *Soper & Dale s.n.* (TRT). NORFOLK: 2 miles west of Walsh P.O., Aug. 12, 1934, *H. H. Brown* (TRT); lot 18, conc. VI, Charlotteville Tp., June 20, 1948, *M. Landon* (McM); Turkey Point, June 27, 1940, *J. H.*

[4]In personal correspondence to W.S.F.

Soper 2021 (DAO, McM); St. Williams, April 28, 1942, *M. D. Kirk* (MDK); lots 1–2, conc. III, Walsingham Tp., about 2 miles northwest of Rowan Mills, Aug. 20, 1952, *J. H. Soper* (s.r.). WELLAND: Niagara, 1908, *W. J. Potter* (TRT); Whirlpool, Niagara River, July, 1897 & July 23, 1903, *Wm. Scott* (TRT); near Fonthill, May 8, 1942, *D. Scott* (McM); Garrison Road, 3 miles west of Fort Erie, June 6, 1948, *R. W. Neal* (DAO); Point Abino, June 24, 1948, *Bert Miller 157* (McM); lot 8, conc. I, Bertie Tp., near Rosehill, May 21, 1950, *J. H. Soper* (s.r.); "along Lake Erie, Crystal Beach to Cedar Bay, Humberstone Tp.," Zenkert (14); along Twelve Mile Creek between its source and the Power Glen, DeCew Falls, *Bert Miller* (corr. WSF). WENTWORTH: West Hamilton, June 28, 1932, *H. A. Senn* (McM); a large tree in Glanford having a diameter of between four and five feet was reported by Logie (11) in 1861.

ANNONACEAE—Custard-Apple Family

3. *Asimina triloba* (L.) Dunal PAWPAW (sometimes spelled PAPAW), CUSTARD-APPLE, WILD or INDIAN BANANA.

The appearance of a member of the tropical Custard Apples as a native of Ontario is no modern phenomenon; it is one of the trees, noted in our general preamble, that were indigenous to Toronto and its hinterland in a long interglacial age hundreds of thousands of years ago. An early Indian name, *Assemina*, scientists easily latinized into the generic, *Asimina*. In his MEMOIRS (Quebec, 1710) Raudot (9), the French traveller, states that fellow-countrymen of his gave the fruit of the Pawpaw "a name in keeping with its shape, which is that of a medium-sized cucumber. This fruit," he writes . . . "is very good and has five or six seeds, as large as the broad beans and of their color." The taste of the Pawpaw (which in Ontario ripens in mid-October) is unique, affecting different palates in different ways. Sir Osbert Sitwell's comment on the Guatemalan Custard Apple applies neatly: it has "a cool, very sweet flavour of mingled banana, pineapple, eau-de-cologne and turpentine." Altogether, its curious fruit, flowers, leaves and the odd anatomy of trunk and branch, make the Pawpaw Ontario's most interesting tree. Moreover, it is now known to be less rare here than was formerly thought.

In a recent issue of the Canadian Field-Naturalist, Bowden and Miller (2) published a comprehensive record of Pawpaw stations in Ontario. The list presented in this paper provides additional data, chiefly verifications through citation of specimens, for some stations noted by them only as sight records. The revised map, Fig. 3, shows the location of the known stands of native Pawpaws.

ELGIN: Near Vienna, May 28, 1950, *Soper & Shields 4468* (TRT). ESSEX: Near Puce on Lake St. Clair, about 10 miles east of Windsor, *Malcom Wallace* (corr. WSF)—no specimen nor recent sight records for this locality. LAMBTON: Lot 9, conc. III, Plympton Tp., Sept. 17, 1951, *W. S. Fox* (TRT); south of Watford, Oct. 11, 1949, *J. F. Calvert* (JFC). LINCOLN: Grimsby, Aug. 1929 [without collector—a specimen presented to the late H. H. Brown of Toronto by a Mr. Blizzard] (TRT); creek flat, lot 96, Niagara Tp., July 5, 1950, *Bert Miller 92* (McM); [? LINCOLN or WELLAND:]

in a grove below Stamford, Aug. 27, 1895, *J. Macoun* (CAN, *No. 59169*, as *Lindera Benzoin*). OXFORD: Near the Norfolk-Oxford county line in South Norwich Township, according to Levi Garrett in London Free Press, May 9, 1951.

LAURACEAE—Laurel Family

4. *Sassafras albidum* (Nutt.) Nees —SASSAFRAS, SASSAFRAX-TREE, SASSAFAC, AGUE-TREE.

The range of this tree is stupendous. It grows in numerous colonies scattered over the immense geographical rectangle outlined by southern Maine, central Florida, the Brazos River in Texas, eastern Oklahoma

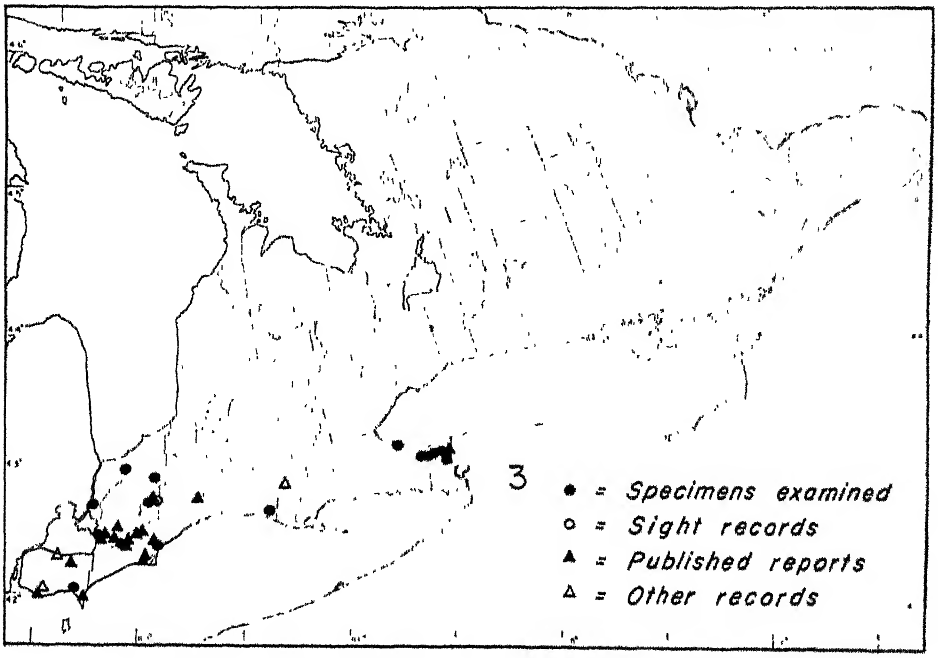

FIG. 3. Distribution of the Pawpaw (*Asimina triloba*).

northern Illinois and southern Ontario. In the last region it is at home in various kinds of sites: though preferring rich sandy loam it thrives also in almost pure sand, either dry or moist, in open spaces or well-shaded; generally appearing in spreading thickets with the height of very tall shrubs, it is known to attain the stature of trees forty feet tall with trunks eighteen inches in diameter.

The Sassafras is probably the most famous of all North American trees. A common source of medicine among the aboriginal tribes it had a high place in Indian folklore. Through the earliest explorers of the southland it gained recognition in the *materia medica* of Europe and soon became a

major article in America's export trade. Most pioneer households were familiar with cordials and healing teas brewed from various parts of the tree. Rare is the country boy of southern Ontario today who does not know the spicy aroma of Sassafras root and twig, and of its variously formed mitten-like leaves.

The distribution of the known stations of Sassafras in southern Ontario is shown on the map, Fig. 4, and the records on which the map is based are listed below.

BRANT: South of Glenmorris, June 10, 1940, *R. M. Lewis* (WO); northwest of Brantford, Aug. 28, 1942, *R. F. Cain* (TRT); Mount Pleasant . . . (*Burgess*) . . . Macoun (12).

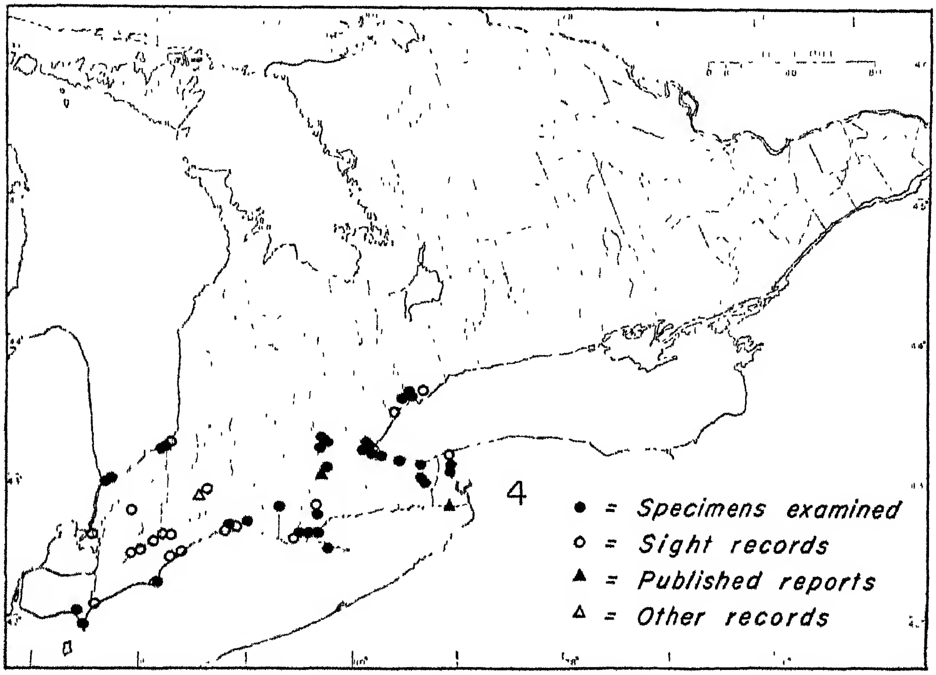

FIG. 4. Distribution of Sassafras (*Sassafras albidum*).

ELGIN: Springwater, Aug. 24, 1941, *D. Young* (TRT); woods near Union, July 18, 1941, *J. F. Calvert* (JFC); lot 12, conc. III, Yarmouth Tp., July 18, 1941, *J. H. Soper* (s.r.); at and near Port Stanley, *W. S. Fox* (s.r.); conc. XIV, Aldborough Tp., near western border of the county, July 28, 1948, *J. H. Soper* (s.r.); about 2½ miles south of Wardsville towards Rodney, *H. L. Lancaster* (corr. WSF). ESSEX: Near Leamington, July 1, 1882, *T. J. W. Burgess* (TRT); Point Pelee, Aug. 31, 1940, *J. H. Soper 2486* (GH). KENT: Rondeau Provincial Park, Aug. 15, 1940, *J. H. Soper 2385* (GH); near Wheatley, Aug. 3, 1950, *J. H. Soper* (s.r.); in Camden and Zone Tps., near Thamesville, *W. S. Fox* (s.r.); lots 7 & 10, river range, Howard Tp., June 24, 1950, *J. H. Soper* (s.r.); near Clearville, Orford Tp., July 27, 1948, *J. H. Soper* (s.r.); Kent Bridge, Aug. 12, 1941, *J. H. Soper* (s.r.). LAMBTON: Near Sarnia, May 20 & Aug. 12, 1894, *C. K. Dodge* (CAN); one mile west of Blackwell, July 24, 1944, *H. Groh* (DAO); Port Franks to

Grand Bend, July 21, 1950, *J. F. Calvert* (JFC); about 11 miles south of Grand Bend, July 18, 1940, *Soper et al. 2204* (DAO, GH, McM); near Grand Bend, *W. S. Fox* (s.r.); about 14 miles south of Reece's Corners, Aug. 31, 1950, *J. H. Soper* (s.r.); north end of Walpole Is., Aug. 4, 1950, *J. H. Soper* (s.r.). LINCOLN: Grimsby, Aug. 12, 1931, *Abram Bater* (TRT); Jordan Station, May 17, 1901, *J. Macoun* (CAN); St. Davids, May 24, 1894, *Wm. Scott* (TRT); near Niagara-on-the-Lake, Aug. 12, 1952, *J. H. Soper* (s.r.). MIDDLESEX: Komoka, *W. S. Fox* (s.r.); near Cashmere, Aug. 12, 1941, *J. H. Soper* (s.r.); Mt. Brydges, *M. Howay* (corr. WSF). NORFOLK: Sandy beach, south shore of Long Point, 11 miles west of lighthouse, June 23, 1951, *Falls & Klawe 456* (TRT); Turkey Point, May 25 & July 5, 1938, *J. H. Soper 54 & 529* (McM); St. Williams, July 3, 1936, *Marie-Victorin et al. 46374* (MT, TRT); Walsingham, June 28, 1944, *W. G. Dore 44-31* (DAO); five miles southwest of Simcoe, Sept. 26, 1937, *H. H. Brown* (TRT); lot 9, conc. XI–XII, Windham Tp., May 28, 1950, *J. H. Soper* (s.r.). OXFORD: Lot 3, conc. XII, Dereham Tp., near Tillsonburg, May 29, 1950, *Soper & Shields 4475* (TRT). PEEL: Beside the C.N.R. tracks, Lorne Park, known since 1894, *W. S. Fox* (s.r.). WATERLOO: Galt, May 29 & July 1, 1893, *W. Herriot* (OAC); near Branchton, July 12, 1942, *F. H. Montgomery 964* (DAO, McM, OAC, WO). WELLAND: Carpenter's Woods [west of Fonthill], Nov. 11, 1945, *W. J. Cody 55 & 55a* (DAO, McM); between Queenston and Niagara Falls, July 30, 1940, *Soper & McCallum 2282* (DAO, GH, McM); Point Abino, Lake Erie (*David F. Day*)--Macoun (12). WENTWORTH: LaSalle Park, northeast of Hamilton, Aug. 21, 1940, & May 22, 1951, *J. H. Soper 2446* (GH) & *5168* (TRT); Hamilton, May 27, 1892, *J. Macoun* (CAN); Binkley's Woods, west of Hamilton-Dundas Highway, May 5, 1943, *F. T. Knapp* (McM); between Waterdown and Aldershot, June 16, 1950, *Soper & Shields 4686* (TRT); near mouth of Stoney Creek, Oct. 12, 1947, *W. J. Cody 991* (DAO). YORK: Rich woods, west of Toronto, July 24, 1877, *J. Macoun* (OAC); Islington, Dec. 24, 1939, *L. T. Owens* (TRT); High Park, Toronto, June 15, 1927, *R. F. Cain* (RFC); East Toronto, west side of upper Balsam Avenue, near Kingston Road: in the 'nineties it was common in the oak woods there, *W. S. Fox* (s.r.).

5. *Lindera Benzoin* (L.) Blume—SPICE BUSH, BENJAMIN BUSH, WILD ALLSPICE, FEVER BUSH.

This close relative of the Sassafras is normally a shrub; only in the extreme south of its Ontario range does it attain the form and size of even a small tree. From its aromatic leaves, as from those of the Sassafras, a tea used as medicine or as beverage was brewed by Indians and early colonists in Ontario and the United States. While the Sassafras is abundant as far south as Florida the Spice Bush reaches northward from North Carolina to Owen Sound. In the southern part of Ontario where these two Laurels are native, stations of both are often found quite close together, the shrub in moist wooded spots, the tree in sandy situations nearby. In this region the Spice Bush is much the commoner of the two though seldom found in equally heavy stands. Although this shrub is usually found in low moist thickets or woods, it is occasionally present on higher, well-drained locations such as riverbanks, open meadows and even on wooded sand hills.

The distribution is shown on the map, Fig. 5, and the records on which the map is based are given in the following list.

ELGIN: Near St. Thomas, June 22, 1901, *J. Macoun* (CAN); Aylmer, April 29, 1898, *Wm. Scott* (TRT); South Yarmouth Tp., Aug. 4, 1941, *D. Young* (TRT); lot 20, conc. IV, Dunwich Tp., July 22, 1948, *J. H. Soper* (s.r.). ESSEX: Pelee Is., July 27, 1892, *J. Macoun* (CAN); Point Pelee, Sept. 22, 1938, *F. A. Urquhart* (TRT); Malden (*Maclagan*)—Macoun (12). GREY: Town Line Lake, northwest of Jackson, June 7, 1952, *M. L. Heimburger* (TRT); Royston Park, Owen Sound—Macoun (12). HALDIMAND: Hagersville, May 5, 1939 [without collector] (DAO); 2 miles east of Dunnville, May 17, 1951, *Bert Miller 13* (McM). HALTON: Bronte, April 21, 1935, *H. H. Brown* (TRT); lot 12, conc. V, Nelson Tp., July 15, 1941, *J. H. Soper* (s.r.); near Oakville, *R. M. Lewis* (corr. WSF). HASTINGS: 2 miles north of Trenton, Aug. 8, 1900, *J. Macoun* (TRT). HURON: Wingham, Aug. 23, 1889, *J. A. Morton* (WO); lot 18, conc. II, W. Wawanosh Tp., 3 miles south of Dungannon, June 20, 1948, *Soper & Dale s.n.* (TRT); Ratz's woods

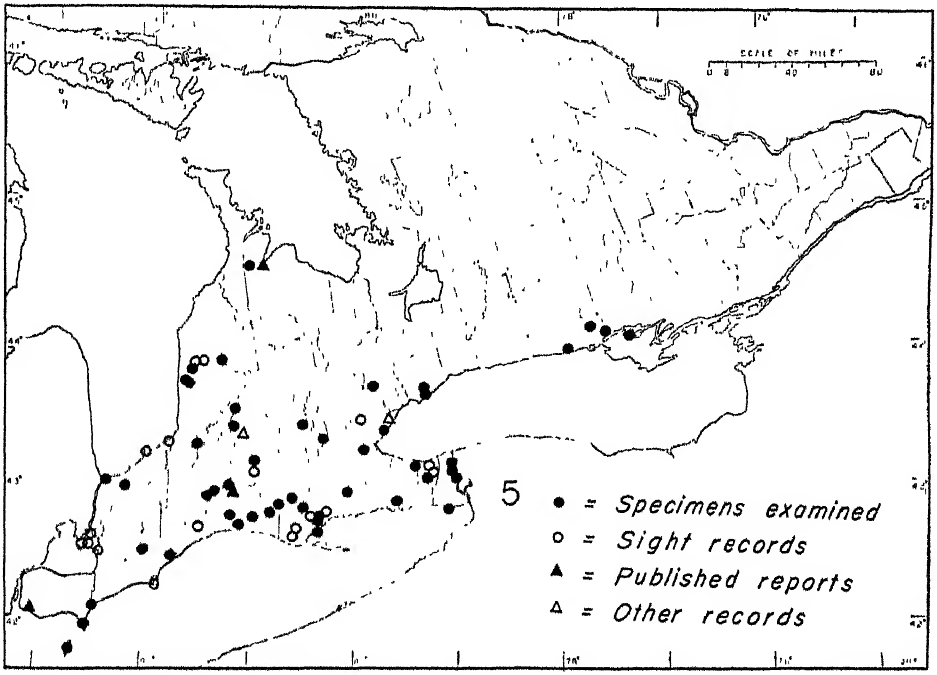

FIG. 5. Distribution of Spice Bush (*Lindera Benzoin*).

[near Crediton], July 31, 1932, *L. O. Gaiser* (McM); along the Maitland River opposite Benmiller, Aug. 1, 1950, *Soper & Shields 4987* (TRT); 3 miles south of Goderich on Maitland River, Aug. 30, 1948, *W. S. Fox* (WO); lot 44, conc. VI, and lot 21, conc. VIII, W. Wawanosh Tp., Aug. 9, 1941, *J. H. Soper* (s.r.). KENT: About 1½ miles north of Clearville, July 28, 1948, *Soper & Dale 4102* (TRT); about 1 mile southeast of Wheatley, Aug. 3, 1950, *Soper & Shields 5073* (TRT); about 3 miles southwest of Thamesville, June 24, 1950, *Soper & Shields 4790* (TRT); Rondeau Provincial Park, July 23, 1948, *J. H. Soper* (s.r.); lot 14, conc. XIII, Dover E. Tp., Aug. 11, 1941, *J. H. Soper* (s.r.). LAMBTON: Sarnia, Sept. 28, 1932, *W. A. Dent* (DAO); lot 9, conc. III, Plympton Tp., Sept. 17, 1951, *W. S. Fox* (TRT); Squirrel Is., July 24, 1948, *J. H. Soper* (s.r.); north and south ends of Walpole Is., Aug. 4, 1950, *J. H. Soper* (s.r.); Kettle Point, Lake Huron, Aug. 10, 1941, *J. H. Soper* (s.r.); near Grand Bend, *W. S. Fox* (s.r.). LINCOLN: Below

escarpment near Vineland, Aug. 13, 1952, *J. H. Soper 5803* (TRT); Queenston, June 11, 1884, *J. Macoun* (CAN); near Brown's Point, Niagara Tp., July 25, 1941, *J. H. Soper 2780* (TRT); lot 8, conc. III, Louth Tp., May 29, 1951, *J. H. Soper* (s.r.); near DeCew Falls, May 22, 1950, *J. H. Soper* (s.r.). MIDDLESEX: London, July 4, 1936, *Marie-Victorin et al. 46,000* (MT); northwest of Lambeth, July 27, 1950, *J. K. Shields 243* (TRT); near Delaware, April 16, 1949, *J. F. Calvert* (JFC); Westminster, July, 1860, *Kate Crooks*—Logie (11). NORFOLK: Delhi, June 23, 1930, *F. C. Hartley* (TRT); Turkey Point, April 24 & June 24, 1938, *J. H. Soper 23 & 509* (McM); lot 15, conc. VII, Charlotteville Tp., Sept., 1951, *M. Landon* (ML); Walsh, Oct. 2, 1938, *H. H. Brown* (TRT). NORTHUMBERLAND: Near Colborne, June 11, 1867, *J. Macoun* (CAN); near Wooler, Aug. 8, 1900, *J. Macoun* (CAN). OXFORD: Tillsonburg, June 24, 1901, *J. Macoun* (CAN); Otterville, Sept. 23, 1927, *R. F. Cain* (TRT); about 5 miles north of Thamesford, May 30, 1950, *Soper & Shields 4514* (TRT); lots 6-7, conc. XIV, Nissouri E. Tp., May 31, 1950, *J. H. Soper* (s.r.). PEEL: Snelgrove, April & Sept. 1, 1913, *J. White* (TRT). PERTH: About 2½ miles southeast of Brodhagen, July 25, 1950, *J. K. Shields 220* (TRT); 3 miles southeast of Mitchell, July 25, 1950, *J. K. Shields 225* (TRT); lot 17, conc. VII, Downie Tp., July 26, 1950, *J. K. Shields* (s.r.). PRINCE EDWARD: Huff's Is., Sept. 17, 1932, *E. G. Anderson* (DAO). WATERLOO: W. of Kitchener, May 2, 1942, *F. H. Montgomery 965* (DAO, McM, OAC); lot 12, conc. VIII, below Galt, April 27 & June 29, 1940, *F. H. Montgomery 596* (DAO, McM, OAC). WELLAND: Dufferin Is., Niagara Falls, Aug. 5, 1913, *W. McCubbin* (DAO); Niagara Glen, May 13, 1937, *J. H. Soper 889* (TRT); Point Abino, May 21, 1950, *Soper & Shields 4404* (TRT); about 3½ miles west of Fonthill, July 5, 1950, *Soper & Shields 4903* (TRT). WENTWORTH: West Hamilton, June 20, 1932, *H. A. Senn* (McM). YORK: Sunnybrook Park, Toronto, May 15, 1932, *H. H. Brown* (TRT); East Toronto, May 9, 1900, *Wm. Scott* (TRT).

PLATANACEAE Plane Tree Family

6. *Platanus occidentalis* L.—SYCAMORE, BUTTONWOOD, PLANE TREE.

The wide distribution of the American Plane Tree is most impressive: the species is native to a great rectangle whose four corners are Maine, Nebraska, central Texas and Georgia; this of course includes southern Ontario. Everywhere its preferred habitat is the low banks and flats of water courses. For that reason it is apt to be overlooked by people who in their country rambles keep to high and dry beaten paths. The Plane Tree is one of our best shade trees and thrives well in town plantings even in dry soils. It sometimes occurs naturally on sand ridges or in sandy woods but usually near the lake shore or where there is a high water table. Its range in Ontario is an excellent illustration of natural "discontinuous distribution" (Fig. 6), but the history of development of such a pattern of distribution has not yet been investigated. The records for each county follow.

ELGIN: Aylmer, July 1, 1898, *R. T. Anderson* (TRT); near St. Thomas, July 13, 1907, *J. Macoun* (CAN); Union, June 6, 1891, *Miss Davidson* (TRT); lot 13, conc. III, Bayham Tp., May 28, 1950, *J. H. Soper* (s.r.); near Eagle, July 28, 1948, *J. H. Soper* (s.r.). ESSEX: Point Pelee, Aug. 29, 1940, *J. H. Soper 2455* (GH); Kingsville, June 26, 1944, *W. G. Dore 44-19* (DAO); Amherstburg—Macoun (12); Pelee and East Sister Islands—

Core (6). GREY: Low river flats of Bighead Creek, Meaford, Aug. 11, 1952, *J. H. Soper 5779* (TRT). HALDIMAND: Lot 10, conc. II, Moulton Tp., May 29, 1948, *J. H. Soper* (s.r.); Grand River flats between Dunnville and Byng, *W. W. Judd* (corr. WSF). HALTON: Oakville (Sixteen Mile) Creek, about 1 mile northwest of Oakville, *R. M. Lewis* (corr. WSF). HURON: Bayfield River at Bayfield, Aug. 1, 1951, *J. H. Soper 5383* (TRT); along the Maitland River opposite Benmiller, Aug. 1, 1950, *Soper & Shields 5000* (TRT); near Crediton, *L. O. Gaiser* (corr. JHS); here and there on banks of Aux Sables River from crossing of Dashwood Road to mouth, *W. S. Fox* (s.r.); near Holmesville and near Goderich, along the Maitland River, *W. S. Fox* (s.r.)—the river flats above Saltford in the 1850's were called "Buttonwood Flats." KENT: Rondeau Provincial Park, Aug. 15, 1940, *J. H. Soper 2367* (DAO, GH); Mitchell's Bay, Lake St. Clair, Aug. 11, 1941, *J. H. Soper 2829* (TRT); lot 18, conc. II, Harwich Tp., Aug. 12, 1941,

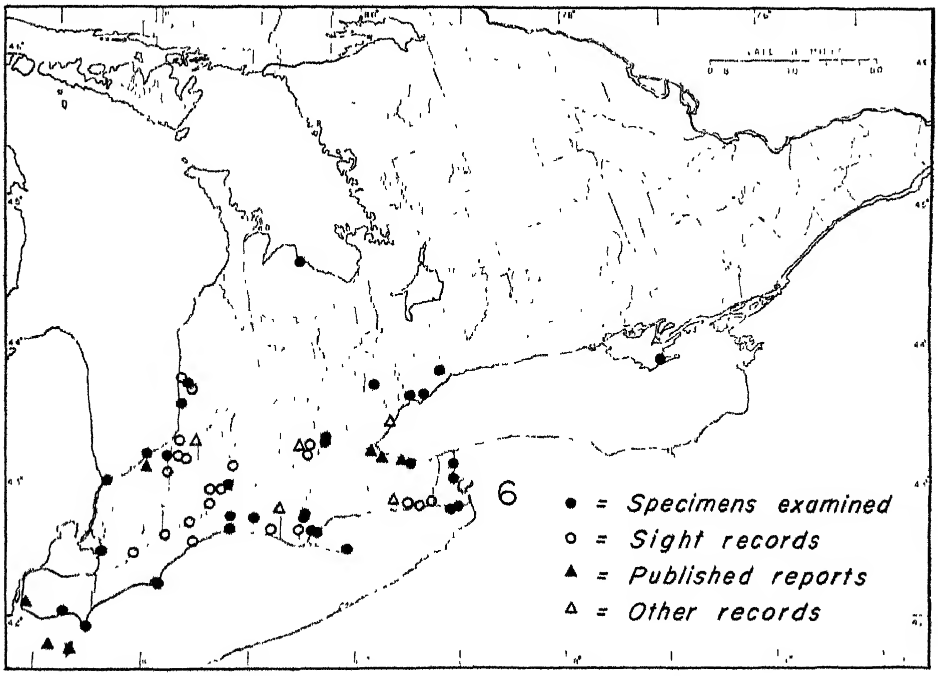

FIG. 6. Distribution of Sycamore (*Platanus occidentalis*).

J. H. Soper (s.r.). LAMBTON: About 2½ miles northeast of Thedford, Aug. 2, 1950, *Soper & Shields 5050* (TRT); Kettle Point, July 21, 1940, *Soper & Burcher 2271* (DAO, McM); Sarnia, Aug. 7, 1930, *H. H. Brown* (TRT); Arkona Rock Glen, Aug. 6, 1950, *J. H. Soper* (s.r.); Forest—Campbell (4). LINCOLN: Beamsville, Oct. 16, 1932, *H. H. Brown* (TRT); Queenston, July 24, 1903, *Wm. Scott* (TRT); Grimsby—Logie (11). MIDDLESEX: London, June 15 & Oct. 19, 1880, *T. J. W. Burgess* (CAN); lot 10, conc. I, Lobo Tp., June 24, 1950, *J. H. Soper* (s.r.); lot 24, conc. II, Mosa Tp., Aug. 12, 1941, *J. H. Soper* (s.r.); along Mud Creek, north of Parkhill and westward toward junction of creek with Aux Sables River, *W. S. Fox* (s.r.); along the Thames River below London to Kent boundary in townships of London, Westminster, Delaware, Ekfrid and Mosa, *W. S. Fox* (s.r.); from London upstream along the north branch of the Thames to St. Mary's, *W. S. Fox* (s.r.). NORFOLK: Turkey Point, June 23, 1935,

W. M. Bowden (McM); St. Williams, April 29, 1942, *M. D. Kirk* (MDK), along Big Creek, conc. XI, Walsingham Tp., May, 1949, *M. Landon* (ML); lot 22, conc. X, Walsingham Tp., July 12, 1948, *M. Landon* (McM); lot 12, conc. VII, Walsingham Tp., May 31, 1951, *J. H. Soper* (s.r.); east end of Long Point, 1951, *W. L. Klawe* (TRT); in Otter valley, near Tillsonburg, *Wm. Miles* (corr. WSF). OXFORD: In the valley of the Nith, east of Drumbo, *Wm. Miles* (corr. WSF); lot 2, conc. V, Blenheim Tp., June 23, 1950, *J. H. Soper* (s.r.). PEEL: Snelgrove, May 24, 1911, *J. White* (TRT). PRINCE EDWARD: Near South Bay, Sept. 4, 1949, *C. & M. Heimburger* (TRT); there is some question as to whether the several trees in this region are native specimens or not, but it seems probable that even if not native, they may have been planted from some original local stock. WATERLOO: Near the footbridge [Galt], June, 1902, *R. S. Hamilton* (OAC); lot 12, conc. IX, below Galt, June 13, 1940, *F. H. Montgomery 613* (DAO, McM, OAC); along the Nith River at Ayr, *W. S. Fox* (s.r.). WELLAND: Niagara, June - [without collector] (TRT); Point Abino, June 22, 1941, *J. H. Soper 2608* (TRT); Dominion Road near Windmill Point, May 30, 1950, *Bert Miller 21* (McM, TRT); lot 32, conc. II, Humberstone Tp., May 28, 1948, and lot 21, conc. I, Wainfleet Tp., May 29, 1948, *J. H. Soper* (s.r.). WENTWORTH: Hamilton—Macoun (12); Stoney Creek Logie (11). YORK: Humber Valley, Toronto, July 18, 1896, *M. Wilkes* (TRT); Don Valley, Toronto, Sept. 18, 1896, *Wm. Scott* (TRT); Rouge River Valley, October 4, 1939, *L. T. Owens* (TRT).

RUTACEAE Rue Family

7. *Xanthoxylum americanum* Mill. PRICKLY ASH, TOOTHACHE TREE.

In the southland the Prickly Ash sometimes grows in tree form to a height of fifteen feet. In Ontario it is always found as a shrub which normally forms into dense thickets. Its habitats are varied: open rocky places, pastures, edges of woods and thickets, fence-rows and roadsides. Though almost unknown to the average citizen it is by no means rare. Its distribution in eastern North America is virtually the same as that of the American Bladder Nut (q.v., infra). Both species fall short of extending into the extreme south but make up for this loss by thrusting northward an equal distance beyond the zone of such typical Carolinian trees as the Sassafras, Flowering Dogwood and Sweet Chestnut. Fig. 7 shows the location of known stations in Ontario and the records are listed below.

BRANT: Lot 27, conc. V, Tuscarora Tp., May 28, 1950, and lot 31, conc. III, Brantford Tp., June 22, 1950, *J. H. Soper* (s.r.). CARLETON: Lot 15, conc. V, Goulbourn Tp., June 19, 1946, *Soper et al. 3186* (DAO, TRT); lot 22, conc. IV, N. Gower Tp., June 3, 1947, *W. G. Dore et al. 47-57* (DAO); Shirley Bay, June 4, 1938, *W. H. Minshall* (DAO); Britannia, July 11, 1947, *W. J. Cody 590* (DAO); on island in the Ottawa River above Chaudiere Falls, June 22, 1903, *J. Macoun* (DAO). DURHAM: West of Cavan, May 12, 1941, *Senn & Zinck 235* (DAO). ELGIN: Aylmer, May 24, 1899, *R. T. Anderson* (TRT). ESSEX: Tilbury Creek, June 26, 1928, *R. F. Cain* (TRT); Fishing Point, Pelee Is., May 10, 1939, *H. A. Senn 1154A* (DAO); near Malden Centre, July 27, 1948, *J. H. Soper* (s.r.); Point Pelee and on Pelee Island—Dodge (7). FRONTENAC: Brewer's Mills, May 16, 1930, *L. O. Gaiser* (McM); Collins Bay, July 17, 1947, *J. M. Gillett* (DAO); Cataraqui, July 12, 1886, *W. Nicol* (QU); Battersea, Aug. 16, 1898, *J. Fowler* (QU); 1½ miles north of Mountain Grove, Sept. 17, 1952, *J. K. Shields* (s.r.). GRENVILLE:

Near Maitland—Billings (1); Browseville, July 20, 1947, *A. F. Coventry* (s.r.). HALDIMAND: East of Dunnville, July 6, 1951, *Bert Miller 420* (McM). HALTON: Lot 15, conc. IV, Nelson Tp., Oct. 7, 1947, *W. J. Cody 984* (DAO). HASTINGS: Belleville, July 1, 1930, *H. H. Brown* (TRT); Ox Point, near Point Anne, June 14, 1950, *Soper & Shields 4658* (TRT). HURON: Wingham, May 27 & June 24, 1891, *J. A. Morton* (CAN); lot 21, conc. VI, Stephen Tp., Aug. 2, 1950, *J. H. Soper* (s.r.); on the east side of Aux Sables River near Grand Bend, *W. S. Fox* (s.r.). KENT: Lot 7, river range, Howard Tp., June 24, 1940, and lot 6, conc. VIII, Zone Tp., June 25, 1950, *J. H. Soper* (s.r.). LAMBTON: Near Port Franks, June 20, 1948, *Soper & Dale s.n.* (TRT); near Corunna, 1937 (?), *W. S. Fox* (WO); along path from Ferry Dock, Walpole Is., Sept. 3, 1945, *L. O. Gaiser 857* (McM); Walpole Is., Aug. 4, 1950, *J. H. Soper* (s.r.). LANARK: Smiths Falls, Aug. 30, 1918, *F. Fyles* (DAO); Almonte, July 28, 1939, *W. H. Minshall*

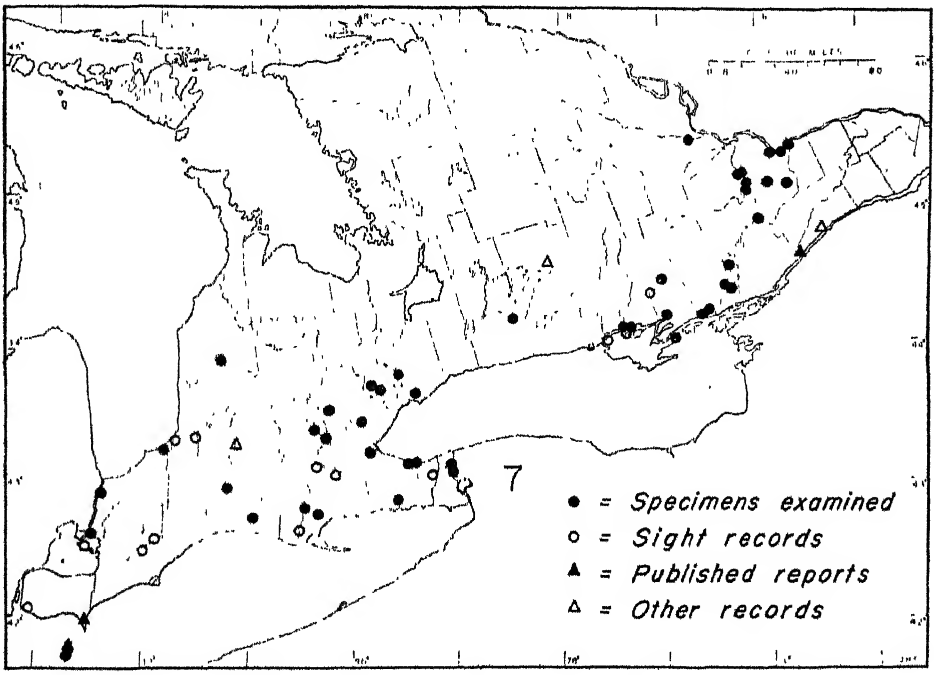

FIG. 7. Distribution of Prickly Ash (*Xanthoxylum americanum*).

1643 (DAO); Wolves Grove, Aug. 4, 1939, *H. A. Senn 1573* (DAO); by Glen Isle, July 3, 1941, *Senn et al. 63* (DAO); Mississippi Lake, July 20, 1941, *M. N. Zinck 971* (DAO). LEEDS: Lake Opinicon, July 3, 1947, *J.M. Gillett 1315* (DAO). LENNOX & ADDINGTON: Napanee, 1913, *M. O. Malte* (CAN); Tamworth, Aug. 14, 1951, *Mulligan & Dore 891* (DAO); lot 1, conc. XI, Richmond Tp., Aug. 14, 1948, *J. H. Soper* (s.r.). LINCOLN: Beamsville, June 17, 1932, *H. H. Brown* (TRT); lot 5, conc. I, Clinton Tp., May 17, 1950, *Soper & Shields 4350* (TRT); near St. Davids, May 19, 1950, *Soper & Shields 4362* (TRT); Queenston Heights, May 18, 1901, *J. Macoun* (CAN); near DeCew Falls, May 25, 1940, *J. H. Soper* (s.r.). MIDDLESEX: 1 mile south of London, May 21, 1950, *J. F. Calvert* (JFC). NORFOLK: Delhi, June 23, 1930, *F. C. Hartley* (RFC); lot 21, conc. VII, Charlotteville Tp., June 1948, *M. Landon* (McM); lot 12, conc. VII, Walsingham Tp., May 31, 1951, *J. H. Soper* (s.r.). PEEL: Snelgrove, July 26, 1911, *J. White*

(TRT); Brampton, June 16, 1888, *T. L. Walker* (QU). PERTH: Near St. Marys, July 26, 1950, *J. K. Shields* (s.r.). PETERBOROUGH: West bank of Trent River about 20 miles above Lakefield, May 25, 1941, *A. E. Porsild* (s.r.). PRINCE EDWARD: Near Cressy, Sept. 4, 1949, *C. & M. Heimburger* (TRT); lot 53, conc. II, Ameliasburgh Tp., Aug. 4, 1951, *J. H. Soper* (s.r.); near Rossmore, Aug. 4, 1951, *J. H. Soper* (s.r.). RENFREW: Renfrew, May 20, 1906, *O. Stewart* (QU). WATERLOO: Doon, July 23, 1902, *A. Cosens* (TRT); lot 12, conc. X, below Galt, June 1, 1940, *F. H. Montgomery 639* (DAO, McM, OAC). WELLAND: Niagara Glen, July 4, 1924, *J. G. Wright* (TRT). WELLINGTON: Guelph, May 16, July 20, 1937, *J. J. Stroud* (TRT). WENTWORTH: Chedoke Ravine, Hamilton, May 3, 1889, *T. J. W. Burgess* (McM). YORK: Near Toronto, July 12, 1898, *ex Biltmore Herb.* (GH); Pine Grove, June 16, 1934, *H. H. Brown* (TRT).

8. *Ptelea trifoliata* L. HOP-TREE, WAFER-ASH.

It will be apparent from the map (Fig. 8) that the Hop Tree is restricted to rather few localities in Ontario. What John Macoun wrote in

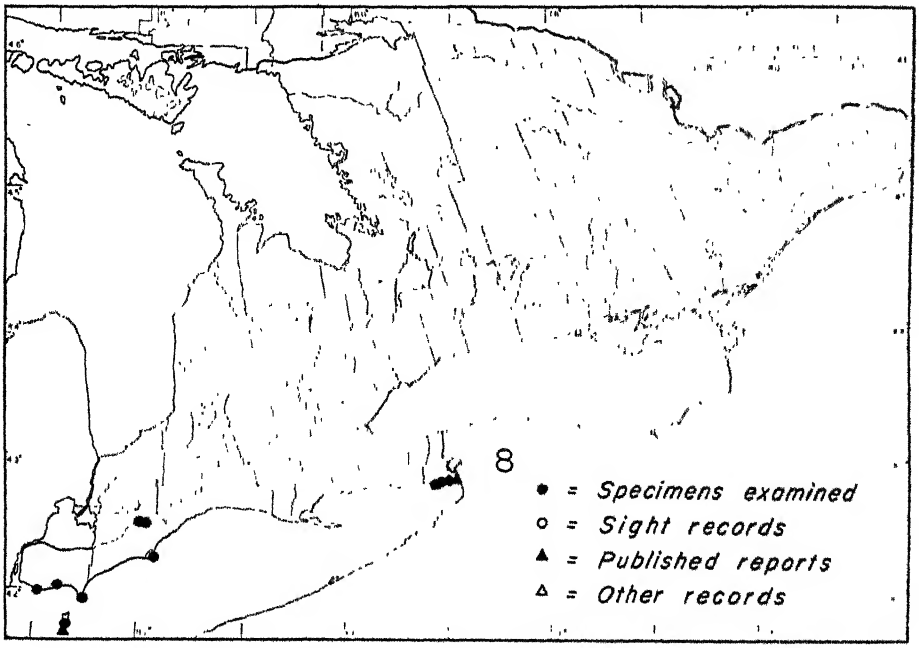

FIG. 8. Distribution of Hop-Tree (*Ptelea trifoliata*).

1883 (12) about this very southern tree (it is found even in Mexico) is, with but little modification, still true: "Confined to the shores of Lake Erie, Pelee Island and west side of Pelee Point." It is an attractive native tree that is easily grown and deserves more attention in ornamental plantings than has been given it in the past. Its natural habitat is sandy soil, on sand dunes, in thickets or open woods, especially along the shores of lakes and rivers. The records for Ontario include the following:

ESSEX: Kingsville, June 26, 1944, *W. G. Dore 44-22* (DAO); Colchester, July 13, 1932, *R. F. Cain 427* (RFC); Point Pelee, July 26, 1948, *Soper & Dale s.n.* (TRT); Pelee Is., June 20, 1915, *J. E. Howitt* (OAC); Middle Is.—Core, (6). KENT: South of Thamesville, July 14, 1928, *R. F. Cain* (TRT); between Highgate and Thamesville about 1½ miles south of Thames River, Aug. 16, 1940, *Soper et al. 2411* (DAO, GH, McM); Rondeau Park, June 20, 1905, *J. H. Faull* (TRT). WELLAND: Point Abino, June 21, 1941, *J. H. Soper 2585* (DAO, TRT); Rosehill, June 28, 1948, *Bert Miller 166* (McM, TRT); near Ridgeway [without date], *C. A. Zenkert* (OAC); Crescent Beach—Zenkert (14).

STAPHYLEACEAE Bladdernut Family

9. *Staphylea trifolia* L. - BLADDERNUT.

In our region this species grows as a large shrub or small tree. Its range (Fig. 9) is similar to that of *Xanthoxylum* and its habitats are rocky woods, river banks and alluvial flats, hillsides, talus slopes of the Niagara

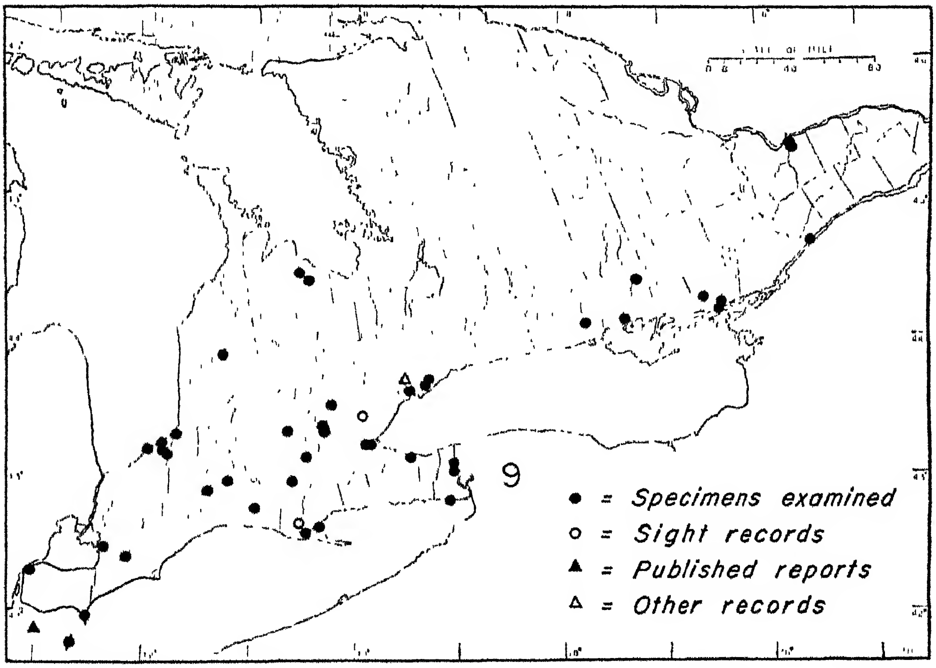

FIG. 9. Distribution of Bladdernut (*Staphylea trifolia*).

escarpment and occasionally wooded sand dunes or ridges. The list of representative specimens and other records follows.

BRANT: Etonia, Oct. 8, 1927, *R. F. Cain* (RFC). CARLETON: Rideau River above Billings Bridge, May 1898, *J. Macoun* (DAO); below Hog's Back, by Whyte R.R. bridge over Rideau River, June 6, 1878, *J. Fletcher* (DAO). ELGIN: Aylmer, June 1, 1898, *R. T. Anderson* (TRT). ESSEX: Sandwich, June 22, 1860, *ex. herb. Wm. Boott* (GH); Pelee Is., 1937, *W. Botham* (DAO); Point Pelee, June 4 & Aug. 5, 1901, *J. Macoun*

(CAN, GH); Middle Sister Is. - Core (6). FRONTENAC: Glenvale, July 8, 1946, *E. A. Moxley* (TRT); Cartwright's Point, June 5, 1886, *W. Nicol* (QU); Kingston Mills, May---, *W. J. Saunders* (QU). GRENVILLE: 3 miles west of Prescott, Aug. 1860, *B. Billings* (QU). GREY: Near Fairmount, May 28, 1879 [without collector] (DAO); Redwing, June 1, 1930, *H. H. Brown* (TRT). HALTON: Lot 14, conc. V, Nelson Tp., April 30, 1949, *J. H. Soper* (s.r.). HASTINGS: Vicinity of Belleville, May 20, 1878, *J. Macoun* (GH); about 1 mile south of Stoco, Aug. 15, 1951, *W. G. Dore 13478* (TRT). HURON: Wingham, May 27 & June 27, 1891, *J. A. Morton* (CAN, WO); Grand Bend, May 24, 1933, *L. O. Gaiser* (McM). KENT: Thames River at Chatham, Sept. 12, 1891, *J. Macoun* (CAN); Mitchell's Bay, Aug. 11, 1941, *J. H. Soper 2830* (TRT). LAMBTON: At and near Thedford, Oct. 12, 1936, and June 20, 1943, *W. S. Fox* (WO); near Grand Bend, June 10, 1934, *L. O. Gaiser* (McM); Kettle Point, Oct. 1, 1952, *C. & M. Heimburger* (TRT). LINCOLN: About 2 miles southeast of Beamsville, Aug. 13, 1952, *J. H. Soper 5817* (TRT). MIDDLESEX: Delaware, May - [without date or collector] (TRT); London, July 24, 1881, *T. Millman* (CAN, TRT). NORFOLK: Turkey Point, May 23, 1948, *M. Landon* (McM); lot 11, conc. A, Walsingham Tp., June 1948, *M. Landon* (ML); lot 12, conc. VII, Walsingham Tp., May 31, 1951, *J. H. Soper* (s.r.). NORTHUMBERLAND: Cold Creek, Sept. 6, 1888, *J. Macoun* (CAN). OXFORD: Norwich, May 27, 1931, *R. F. Cain* (RFC). WATERLOO: About 1 mile south of Haysville on the Nith River, July 6, 1941, *J. H. Soper 2682* (TRT); Preston, Sept. 6, 1947, *H. Groh* (DAO); lot 11, conc. XII, above Galt, June 13 & Sept. 15, 1940, *F. H. Montgomery 650* (DAO, McM, OAC). WELLAND: Niagara, July - -, *Dr. Cowdry* (TRT); Niagara Glen, May 13, 1937, *R. Burcher* (DAO); Point Abino, June 21, 1941, *J. H. Soper 2587* (DAO, TRT). WELLINGTON: Guelph, May 29, 1937, *J. J. Strond* (TRT). WENTWORTH: Mountain brow at Hamilton, July 24, 1941, *J. H. Soper 2764* (TRT); Chedoke Ravine, Hamilton, June 9, 1889, *A. E. Walker* (McMHA). YORK: On the banks of the Humber, Toronto, June 2, 1943, *H. H. Brown* (TRT); Sunnybrook Park, Toronto, June 6, 1936, *M. D. Kirk* (MDK); Wexford, Don Valley, June 6, 1930, *H. H. Brown* (TRT); Thistletown, *A. F. Coventry* (s.r.).

CORNACEAE—Dogwood Family

10. *Cornus florida* L. FLOWERING DOGWOOD.

"What a pity that the Flowering Dogwood is not found in Canada!" This lament is often uttered by citizens of Ontario on their return home in spring after a winter holiday in the southern United States. Plainly, they do not know their Province. Here are the facts: the Flowering Dogwood, the queen of southern trees, is a genuine native of Ontario; in certain parts it is abundant and displays not a few specimens which in size, vigour and rich beauty equal any to be seen in the southland. It is common in a broad zone that parallels the lake Erie shoreline and reaches from Fort Erie and Queenston on the east to Amherstburg on the west. It is known just north of the Lake Ontario town of Bronte, well inland between Galt and Paris, in London, and, on the Lake Huron side of the Province, near Thedford and Sarnia. The very appearance here, as a native, of this most typical of southern trees, may rightly be regarded as an impressive symbol of the Carolinian character of a considerable part of the flora of southern Ontario.

The habitat of the Flowering Dogwood in Ontario is varied. The commonest situation is in dry, sandy or well-drained open woods such as develop on river banks and slopes of ravines. Occasionally it occurs in low wet woods but dense shade appears to produce less floriferous trees. The distribution is shown Fig. 10 and the following is a list of records plotted.

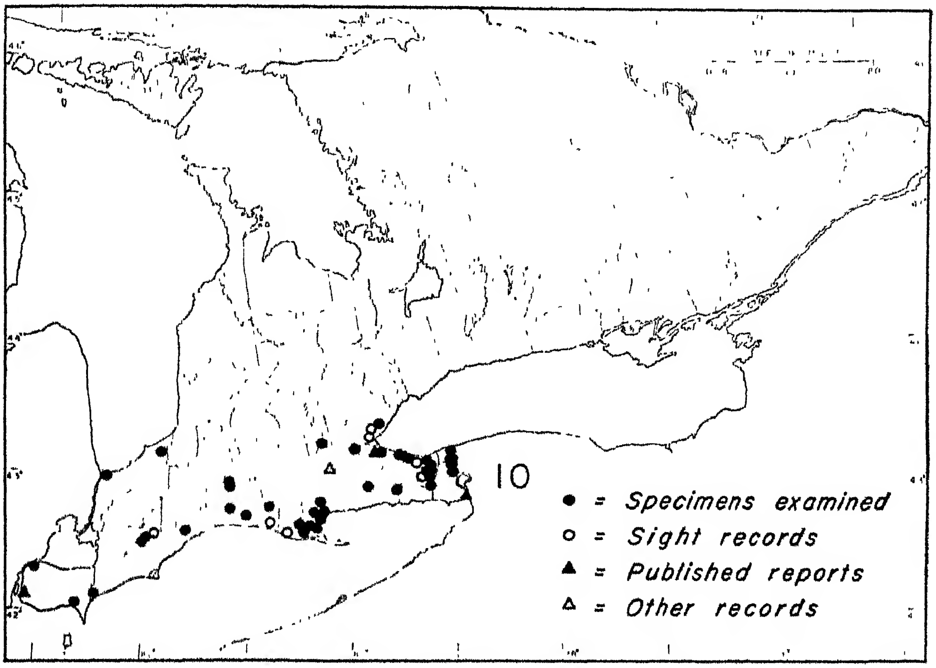

FIG. 10. Distribution of Flowering Dogwood (*Cornus florida*).

BRANT: East of Glen Morris, June 10, 1940, *R. M. Lewis* (WO); south of Brantford, *H. Cockshutt* (corr. WSF). ELGIN: About 5 miles southwest of Tillsonburg, May 29, 1950, *Soper & Shields 4483* (TRT); Bismarck, May 17, 1882, *J. Macoun* (OAC); St. Thomas, May 26, 1902, *ex herb. G. L. Fisher* (GH); Springwater, May 25, 1941, *Donald Young* (TRT); near Vienna, *W. S. Fox* (s.r.). ESSEX: Leamington, May 30, 1901, *J. Macoun* (CAN); Windsor, Oct. 1885, *J. Macoun* (CAN); Amherstburg—Macoun (12). HALDIMAND: Cayuga, May——, *ex herb. Royal Can. Inst.* (TRT); 3 miles south of Port Davidson, May 30, 1951, *Bert Miller 143* (McM). HALTON: Merton, June 25, 1938, *H. H. Brown* (TRT); north of Burlington in Nelson Tp., *W. S. Fox* (s.r.). KENT: About 1 mile southeast of Wheatley, Aug. 3, 1950, *Soper & Shields 5071* (TRT); Thamesville, July 26, 1944, *H. Groh 2261* (DAO); about 2 miles southwest of Thamesville, June 24, 1950, *Soper & Shields 4796* (TRT); lot 6, conc. III, Zone Tp., June 25, 1950, *J. H. Soper* (s.r.). LAMBTON: Near Sarnia, May 27 & June 28, 1894, *C. K. Dodge* (CAN); Thedford, 1939, *G. Houghton* (WO—a wood specimen). LINCOLN: 1 mile west of St. Davids, July 5, 1950, *Soper & Shields 4893* (TRT); Queenston Heights, Sept. 20, 1902, *Wm. Scott* (TRT); 1½ miles south of Grimsby Beach, May 22, 1951, *J. H. Soper 5169* (TRT); along Fifteen-Mile Creek near Lake Ontario, May 29, 1951,

J. H. Soper 5175 (TRT); Beamsville, July 4, 1950, *Soper & Shields 4876* (TRT); DeCew Falls, May 30, 1930, *C. A. Zenkert* (OAC); Niagara-on-the-Lake, June 1, 1943, *R. S. Haines* (McM); about 1½ miles south of Vineland, Aug. 13, 1952, *J. H. Soper* (s.r.); lot 8, conc. III, Louth Tp., May 29, 1951, *J. H. Soper* (s.r.). MIDDLESEX: London, May 25, 1880, *T. Millman* (DAO); Westminster Ponds, May 22, 1879, *T. J. W. Burgess* (DAO). NORFOLK: Turkey Point, May 25, 1938, *J. H. Soper 65* (DAO, McM); St. Williams, Oct. 2, 1938, *H. H. Brown* (TRT); Port Rowan, July 31, 1937, *W. S. Fox* (WO); Simcoe, Sept. 26, 1937, *H. H. Brown* (TRT); Walsingham, June 9, 1928, *R. F. Cain* (TRT); Port Ryerse, May 7, 1949, *M. Landon* (ML); Walsh, May 21, 1933, *H. H. Brown* (TRT); Fisher's Glen, June 2, 1935, *W. M. Bowden* (McM); near Rowan Mills, Aug. 20, 1952, *J. H. Soper* (s.r.). WELLAND: Welland, May 24, 1910, *T. J. Ivey* (TRT); Whirlpool, Niagara River, May 24, 1897, *Wm. Scott* (TRT); Niagara Falls, July 27, 1877, *J. Macoun* (QU); Fonthill, June 3, 1948, *Bert Miller* (McM); between Fonthill and Ridgeville, May 22, 1950, *Soper & Shields 4409* (TRT); lot 1, conc. IV, Pelham Tp., May 28, 1948, *Soper & Dale 3762* (TRT); lot 15, conc. VIII, Pelham Tp., May 23, 1951, *J. H. Soper* (s.r.). WENTWORTH: Sulphur Springs, near Ancaster, May 20, 1937, *J. H. Soper 892* (TRT); Stoney Creek, May 17, 1889, *Mrs. Lounsbury* (McMHA); near Albion (*Logie*)-Macoun (12); east of Dundas along north shore of marsh, *W. S. Fox* (s.r.).

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TRANSACTIONS

of the

Royal Canadian Institute

VOLUME XXIX

1951 — 1952

CONTENTS

TRANSACTIONS

OF THE

Royal Canadian Institute

No. 62 | October, 1953 | Vol. XXX, Part I

191 COLLEGE STREET
TORONTO 2B, CANADA

THE DISTRIBUTION OF SOME TREES AND SHRUBS OF THE CAROLINIAN ZONE OF SOUTHERN ONTARIO[1]

PART II

W. SHERWOOD FOX[2] AND JAMES H. SOPER[3]

INTRODUCTION

IN PART I of this series[4] the authors outlined in detail the distribution in Ontario of ten species of trees and shrubs characteristic of the Carolinian Zone, which is roughly that part of Ontario south of a line joining Grand Bend on Lake Huron and Toronto on Lake Ontario. In this paper similar data and maps are presented for an additional seventeen species indigenous in the same region. A final group of species, together with discussions and conclusions, form the concluding part of this series which is to be published later. The following are the species to be discussed in this paper:

11.[5] *Juniperus virginiana* L.	PINACEAE
12. *Populus deltoides* Marsh.	SALICACEAE
13. *Juglans cinerea* L.	JUGLANDACEAE
14. *Juglans nigra* L.	JUGLANDACEAE
15. *Castanea dentata* (Marsh.) Borkh.	FAGACEAE
16. *Celtis tenuifolia* Nutt.	ULMACEAE
17. *Morus rubra* L.	MORACEAE
18. *Hamamelis virginiana* L.	HAMAMELIDACEAE
19. *Pyrus coronaria* L.	ROSACEAE
20. *Prunus serotina* Ehrh.	ROSACEAE
21. *Cercis canadensis* L.	LEGUMINOSAE
22. *Gleditsia triacanthos* L.	LEGUMINOSAE
23. *Gymnocladus dioica* (L.) K. Koch	LEGUMINOSAE
24. *Euonymus atropurpurea* Jacq.	CELASTRACEAE
25. *Nyssa sylvatica* Marsh.	NYSSACEAE
26. *Fraxinus quadrangulata* Michx.	OLEACEAE
27. *Cephalanthus occidentalis* L.	RUBIACEAE

SYMBOLS AND ABBREVIATIONS

The same symbols have been used on the maps as in Part I and these have been explained on page 68 of that paper. Similarly the same abbreviations for herbaria

[1]Manuscript received October 6, 1953.

[2]Former President of the University of Western Ontario, London.

[3]Assistant Professor of Botany and Curator of the Herbarium of Vascular Plants, University of Toronto, Toronto.

[4]Part I was published in the Transactions of the Royal Canadian Institute, Vol. XXIX, Part II, pp. 65–84, 1952.

[5]The numbers of the species discussed here and of the figures containing the maps to accompany these species begin at 11 in order to continue the arrangement used in Part I of the series and to allow reference to the previous maps.

are employed here as in Part I. The following abbreviations are for herbaria not previously cited: BUF—Buffalo Museum of Science, Buffalo, New York; FFT—Faculty of Forestry, University of Toronto, Toronto, Ontario; LFR—Ontario Department of Lands and Forests, Research Division, Maple, Ontario; McG—Department of Botany, McGill University, Montreal, Quebec; NPC—Niagara Parks Commission, School for Apprentice Gardeners, Niagara Falls, Ontario; WWJ—Herbarium of W. W. Judd, Department of Zoology, University of Western Ontario, London, Ontario.

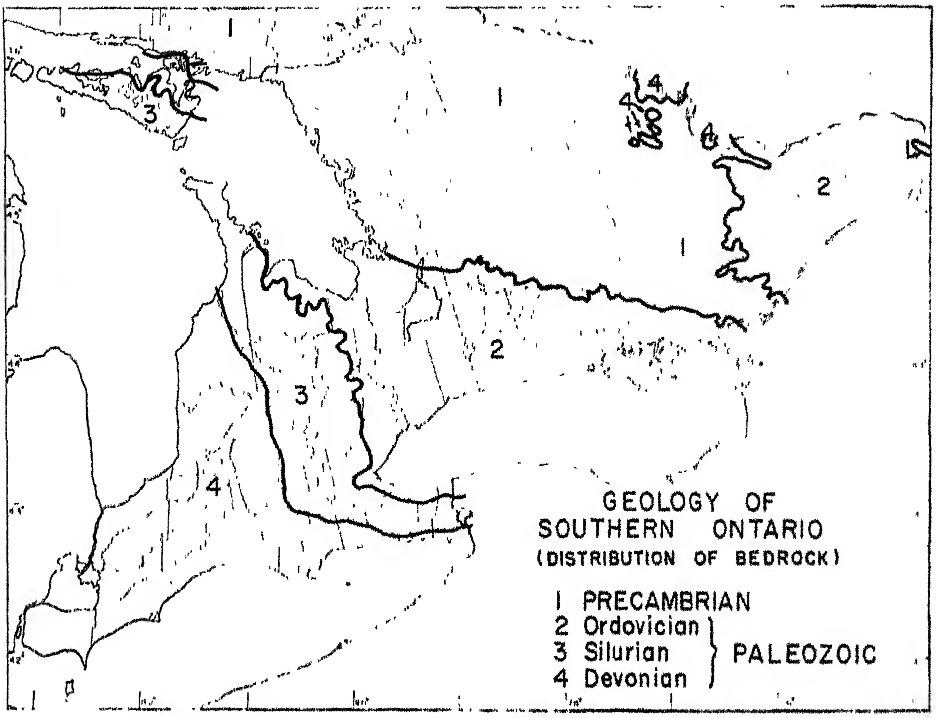

FIG. 11. Map of Southern Ontario showing the distribution of the types of bedrock exposed or immediately underlying the soil or surface deposits (Boundaries redrawn from Geological Map No. 820A, Dominion of Canada, 1945).

DISCUSSION OF SPECIES

PINACEAE—Pine Family

11. *Juniperus virginiana* L. (incl. var. *crebra* Fern. & Grisc.) RED CEDAR OR SAVIN.

Nature gave the Red Cedar nearly half a continent as its homeland—the vast region bounded by northern Florida, eastern Texas, Oklahoma, the Dakotas, southern and eastern shores of Lake Huron, Quebec and Nova Scotia. In Ontario it is very rare north of Goderich on Lake Huron, though not uncommon at more northern latitudes along the east side of Georgian Bay. The records made by early observers for islands or points along the north shore of Lakes Huron and Superior

should be regarded with caution because of occasional reports of the prostrate juniper, *J. horizontalis* Moench, as a variety (but without designation as such) of *J. virginiana*. (see below under Excluded Records.)

Red cedar occupies several types of habitats in Ontario, the commonest perhaps being, in general, dry sandy or rocky ground, most frequently in soil over limestone. A few occurrences on igneous outcrops have been reported on or near the contact line between the Precambrian and the Ordovician (Fig. 11). It has also been noticed that in certain areas red cedar appears to be a primary arborescent species invading abandoned fields and pastures but no detailed studies have been

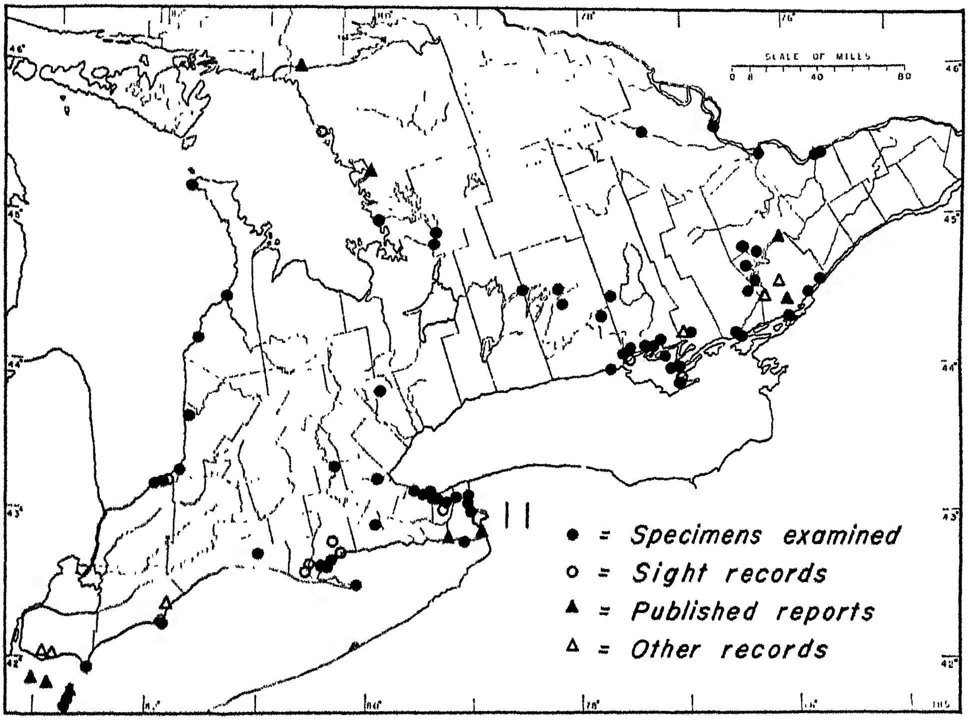

FIG. 12. Distribution of Red Cedar (*Juniperus virginiana*).

made of the distribution of these areas or of the development of such an "old-field" succession. In the southeastern part of New England an association of red cedar and gray birch has been described and mapped by Raup (38) as one of the important types of old field succession.

The distribution of our records for red cedar in Ontario is shown by Fig. 12, and the following data give the details by county and district.

BRUCE: near Cape Hurd, Aug. 22, 1901, *J. Macoun* (CAN); sands, Southampton, Aug. 20, 1901, *J. Macoun* (CAN); dry places, Kincardine, Aug. 28, 1892, *J. A. Morton* (WO). CARLETON: upper bank of rocky shore line along Ottawa River, Morris Island, Sept. 12, 1948, *Calder & Gillett 2798* (DAO); on the limestone ledge of a small island in the Ottawa River just above the city [of Ottawa], Sept. 28, 1950, *W. G. Dore et al. 12919* (DAO). ELGIN: Aylmer, *R. T. Anderson* (TRT). ESSEX: along east beach of Point Pelee, Aug. 31,

1940, *J. H. Soper 2489* (GH); moist woodland, Fishing Point, Pelee Island, May 10, 1939, *H. A. Senn 1140* (DAO); Middle Island, May 9-10, 1939, *H. A. Senn 1119* (DAO, TRT): North Harbor Island and Middle Sister Island—Calvert (18); abandoned field near Harrow, May 23, 1950, *Conners & Parmelee* (s.r.); near Kingsville, June 10, 1953, *J. K. Shields* (s.r.). FRONTENAC: Cedar Island, Kingston, July 25, 1900, *J. K. McMorine* (DAO); Barriefield, July 10, 1897, *Annie A. Boyd* (QU); open rocky hill near Upper Rock Lake, July 22, 1952, *J. K. Shields* (TRT). HALDIMAND: soil over limestone, 3 miles northeast of Nelles Corners, July 26, 1951, *Bert Miller 490* (McM). HASTINGS: Belleville, Aug. 27, 1929. *H. H. Brown* (TRT); abandoned field, Trenton, May 12, 1940, *H. A. Senn 1576* (DAO): two miles east of Shannonville, July 14, 1939, *W. H. Minshall 661* (DAO); Sidney, *A. H. Richardson* (McM): near Point Anne, June 14, 1950, *Soper & Shields 4655* (TRT); igneous outcrop near Crow Lake, north-northeast of Marmora, June 26, 1952, *Gillett & Calder 6292* (DAO). HURON: lot 21, conc. II, Goderich Tp., Aug. 8, 1952, *W. S. Fox* (TRT). KENT: sandy field, Rondeau Provincial Park, Aug. 16, 1940, *J. H. Soper 2404* (GH); deep gravelly ravine, Morpeth, May 11, 1950, *Conners & Parmelee* (s.r.). LAMBTON: sand dunes between Port Franks and Stoney Point, Aug. 2, 1950, *Soper & Shields 5048* (TRT); Grand Bend, Aug. 1937, *W. S. Fox* (WO); the Cut, near Port Franks, June 20, 1948, *J. H. Soper* (s.r.). LANARK: one mile east of Black Lake, North Burgess Tp., May 16, 1952, *W. J. Cody et al. 6343* (DAO, fide W. G. Dore); south side of Christie Lake, July 19, 1952, *Dore & Mills 13803* (DAO, fide W. G. Dore). Big Rideau, on the north shore nearly opposite Sand Island—Morris (37). LEEDS: Brockville, May 20, 1935, *R. Meilleur* (MT); Wallace Island, May 13, 1940, *H. B. Sifton* (TRT); north-west shore of Lake Opinicon, Aug. 23, 1945, *J. H. Soper et al. 2991* (DAO); on dry exposed granite, Westport, July 24, 1947, *Dore & Cody 47–367* (DAO); Blue Mountain—Young (44); Seeley's Bay and Lyndhurst Station, May 18, 1950, *Conners & Parmelee* (s.r.). LENNOX & ADDINGTON: Napanee, Oct. 1, 1939, *E. G. Anderson* (DAO); Mount Pleasant, May 18, 1950, *Conners & Parmelee* (s.r.). LINCOLN: Queenston, Aug. 20, 1949, *A. E. Straby* (OAC); lot 5, conc. I, Clinton Tp., May 17, 1950, *Soper & Shields 4361* (TRT); along the Niagara Escarpment, Grantham Tp., Oct. 9, 1930, *C. A. Zenkert* (OAC); Vineland, June 22, 1940, *H. M. Harrison* (OAC); Grimsby, 1917 [without collector] (McM); at rim of gully, DeCew Falls, Nov. 11, 1945, *W. J. Cody* (DAO, McM); Beamsville, June 30, 1929, *H. H. Brown* (TRT); 4 miles west of St. Catharines, June 2, 1952, *Bert Miller 220* (McM). MUSKOKA: rocky shores, Go Home, June 28, 1904, *A. G. Huntsman* (TRT); Sparrow Lake, Oct. 10, 1939, *D. W. Kirk* (MDK); west Gravenhurst, Sept. 2, 1936, *H. Groh* (DAO). NORFOLK: in a horsetail meadow, Turkey Point, June 22, 1938, *J. H. Soper 182* (DAO, McM); sandy hill, Long Point, June 18, 1951, *W. L. Klawe 433* (TRT); St. Williams, June 1, 1928, *R. F. Cain* (RFC); open sandy area, Normandale, Aug. 28, 1943, *W. H. Minshall 3381* (DAO); lots 4-5, conc. III-IV, Walsingham Tp., Aug. 20, 1952, *J. H. Soper* (s.r.); Simcoe, Aug. 12, 1950, *J. L. Harvey* (s.r. JHS); lot 12, conc. VII, Walsingham Tp., May 31, 1951, *J. H. Soper* (s.r.); lot 1, conc. I, Woodhouse Tp., July 13, 1940, *J. H. Soper* (s.r.). NORTHUMBERLAND: in dry sand dunes, Presqu'ile Park, June 13, 1950, *Soper & Shields 4640* (TRT); limestone cliff, Healey Falls on Trent River, Aug. 4, 1947, *Dore & Senn 47–665* (DAO). PARRY SOUND: Lake Huron at Parry Sound (*R. Bell*)—Macoun (12); along rocky shores of Georgian Bay, Pointe au Baril, *W. S. Fox* (s.r.); at the last rapids on the French River—Klugh (30). PEEL: Caledon East, June 27, 1948, *V. H. H. Williamson* (LFR). PETERBOROUGH: in over-pastured field, about 3 miles north of Warsaw, Aug. 1, 1951, *C. & M. Heimburger* (TRT); on limestone, one mile south of Burleigh Falls, Aug. 2, 1951, *C. & M. Heimburger* (TRT). PRINCE EDWARD: between Lake-on-the-Mountain and Glenora, Sept. 4, 1949, *C. & M. Heimburger* (TRT); in field, Picton, July 13, 1939, *W. H. Minshall 468* (DAO); Demorestville, July 13, 1939, *W. H. Minshall 572* (DAO); near South Bay, Oct. 22, 1950, *C. & M. Heimburger* (TRT); mouth of Black River, Aug. 5, 1951, *J. H. Soper* (s.r.); lot 102, conc. I, Ameliasburgh Tp., June 14, 1950, *J. H. Soper* (s.r.). RENFREW: open ground, Deacon, July 29, 1948, *Groh & Lloyd 3372* (DAO); Portage du Fort, Aug. 4, 1940, *C. H. D. Clarke* (CAN). VICTORIA: on limestone, Bobcaygeon, May 4, 1952, *M. D. Kirk* (TRT).

WATERLOO: river flats at Galt, July 22, 1893, *W. H. Herriot* (OAC). WELLAND: south of Queenston Power House, May 19, 1950, *Soper & Shields 4387* (TRT); sand over limestone, Point Abino, Oct. 26, 1948, *Bert Miller 920* (McM, TRT); Niagara Falls, Sept. 3, 1894, *W. J. Scott* (CAN); lot 7, conc. I, Pelham Tp., May 29, 1951, *J. H. Soper* (s.r.); Port Colborne and Fort Erie (*David F. Day*)—Macoun (12). WENTWORTH: Area B, Royal Botanical Garden [Hamilton], June 25, 1932, *H. A. Senn* (McM).

EXCLUDED RECORDS: In a list published in 1861 (16) Bell reported *Juniperus virginiana* from "Namainse [now Mamainse], gravelly and rocky shore, August 15th" and also from the "south side of La Cloche Island, October 2nd". These would be the northernmost records for Red Cedar in Ontario but no specimens or other reports have been seen to verify the records. Furthermore, in a Supplementary List, published at the end of the same article, Bell reports *Juniperus virginiana* again followed by the name Red Cedar (prostrate variety) from "rocky and gravelly situations on east side of Lake Superior [which could include the Namainse reported earlier] and north side of Lake Huron" [which could include La Cloche Island.] It seems likely that Bell used the name *Juniperus virginiana* either for the prostrate plant which is *J. horizontalis* or for both the upright red cedar and the prostrate trailing shrub. It may be noted also that Macoun (12) did not report red cedar from any locality north of Parry Sound on Lake Huron. Unless verification of Bell's records is found, the Mamainse and La Cloche localities should be regarded as doubtful. The prostrate plant, *J. horizontalis*, is found on La Cloche Island, Manitoulin, and on both the east and north shores of Lake Superior.

SALICACEAE—Willow Family

12. *Populus deltoides* Marsh.—COTTONWOOD, EASTERN COTTONWOOD, BIG COTTONWOOD, COTTON-TREE, NECKLACE-POPLAR.

This poplar is known throughout the whole territory of the eastern part of the United States. Specimens of great size are found in damp rich river valleys of the tract of the Ontario peninsula lying south of a Toronto-Grand Bend line. One is not surprised to note isolated groups of examples at the eastern end of Lake Ontario and in the Ottawa valley since this species ranges into northeastern New York and southwestern Quebec at the northeastern limit of its territory.

The common habitats of the Cottonwood in Ontario are sandy flats, river bottoms and lake shores. The records of its distribution are shown in Fig. 13, and include those listed below.

CARLETON: wet sandy place, Merivale, Sept. 21, 1947, *A. J. Breitung 6135* (DAO); just below Billings Bridge, June 10, 1893, *J. Macoun* (DAO); along the Rideau River, Eastview, Ottawa, May 24, 1946, *A. J. Breitung 2243* (DAO). ESSEX: shore of Lake Erie, Point Pelee, Aug. 7, 1932, *Fr. Marie-Victorin et al. 49254* (MT); Pelee Island, Middle Sister Island, Hen Island, Little Chicken Island and Middle Island—Core (6); East Sister Island and North Harbor Island—Calvert (18). FRONTENAC: Kingston, May 14 & Aug. 3, 1879, *D. Murray* (DAO, TRT). HASTINGS: swamps and borders of ponds, Belleville, May 20, 1878, *J. Macoun* (CAN). KENT: woods about one mile south of Prairie Siding, Aug. 3, 1950, *J. H. Soper* (s.r.); Mitchell Bay, Aug., 1950, *J. K. Shields* (s.r. JHS); upper beach, Rondeau Park—Faull (21). LAMBTON: near Thedford, July 21, 1939, *W. S. Fox* (WO); sand dunes along shore of Lake Huron between Port Franks and Stoney Point, Aug. 2, 1950, J. H. Soper (s.r.); Squirrel Island, Lake St. Clair, July 24, 1948, J. H. Soper (s.r.). LINCOLN: Queenston Heights, May 18, 1901, *J. Macoun* (CAN); St. Davids, Dec. 1, 1946, *W. J. Lamoureux* (NPC); near Niagara-on-the-Lake—Hamilton (26). MIDDLESEX: Pond Mills, July 19, 1950, *J. K. Shields* (s.r.). NORFOLK: lot 18, conc. VI, Charlotteville Tp., Apr. 9, 1949, *M. Landon* (ML); sand hill, Long Point, June 7, 1951, *W. L. Klawe 388* (TRT); Long Point, July 26, 1936, *M. Landon*

et al. (McM); Turkey Point, May 24, 1934, *H. H. Brown* (TRT). NORTHUMBERLAND: on Presqu'ile Point, Lake Ontario Macoun (12). PRESCOTT: on rocky shore line of Ottawa River, northeast of l'Orignal, Aug. 11, 1941, *W. H. Minshall 2530* (DAO). PRINCE EDWARD: sandy barrier beach, Wellington, June 13, 1910, *A. B. Klugh* (QU); Traverse, June 30, 1930, *H. H. Brown* (TRT); sand banks near Bloomfield, July 10, 1947, *J. M. Gillett 1377* (DAO). WATERLOO: roadside at Moffat's swamp, Galt, July 2, 1904, *W. Herriot* (OAC). WELLAND: Niagara Glen, July 30, 1931, *C. A. Zenkert* (BUF): Point Abino, June, 19, 1921, *F. W. Johnson 326* (BUF); Queen Victoria Park, Sept. 13, 1950, *E. L. Cachia* (NPC). WELLINGTON: borders of streams, Guelph, June 8, 1937, *J. J. Stroud* (TRT). WENTWORTH: Hamilton—Dickson & Alexander (19). YORK: Humber Valley, Toronto, Feb. 19, 1939, *J. Simon* (TRT); Toronto Island, July 22, 1932, *H. H. Brown* (TRT): Leslie Beach, Toronto, May 5, 1941, *D. W. Kirk* (MDK).

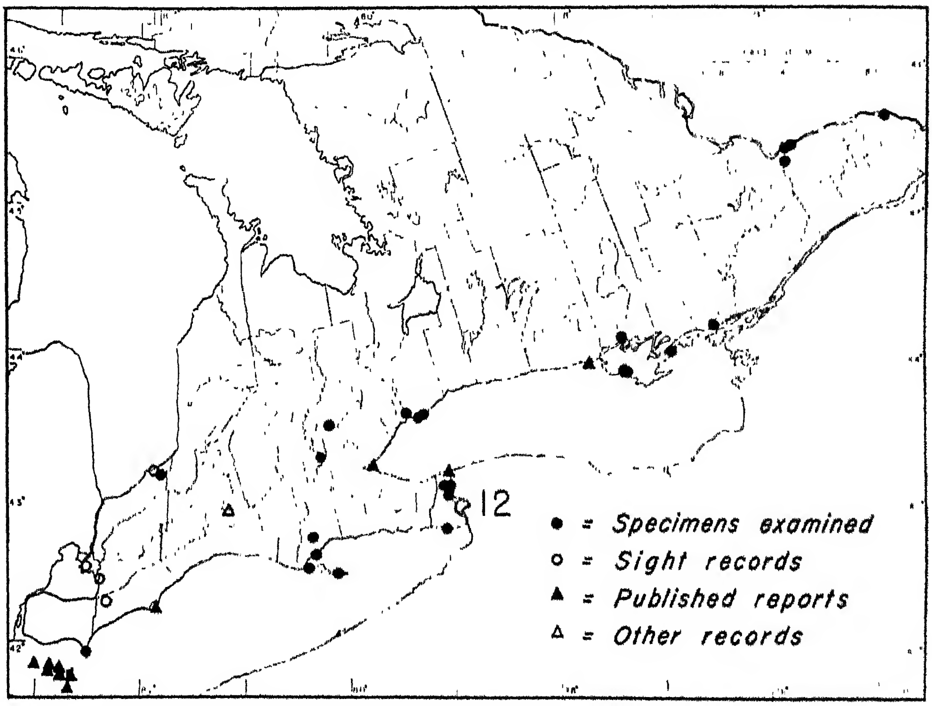

FIG. 13. Distribution of Eastern Cottonwood (*Populus deltoides*).

JUGLANDACEAE—Walnut Family

13. *Juglans cinerea* L.—BUTTERNUT, WHITE WALNUT.

The Butternut is a southern tree of an exceptional hardiness that enables it to thrive under rigours of climate which its congener, the Black Walnut, barely endures. Hence we find it reaching northward in Ontario to Lion's Head on the Bruce Peninsula and even farther northward on the Ottawa River. Similarly, in the Carolinas, Georgia, and Alabama, it finds congenial temperatures in the Mountains. Like the Walnut, it is generally distributed among the trees of the mixed forest of southern Ontario.

The distribution of Butternut in Ontario (Fig. 14) shows a good correlation

with that of the areas immediately underlain by Devonian, Silurian and Ordovician strata (cf. map, Fig. 11). This may or may not be significant, but in any case the Butternut is a common species in the mixed hardwood and conifer forest along the Niagara Escarpment where these basic rocks—chiefly limestones and dolomites—are exposed. Conversely it is absent, with one or two possible exceptions (near the contact line) from the chiefly acid rocky land of the Canadian Shield: for example, it is not known to occur in Muskoka, Haliburton, Nipissing or Parry Sound Districts.

The list of representative specimens and other records follows:

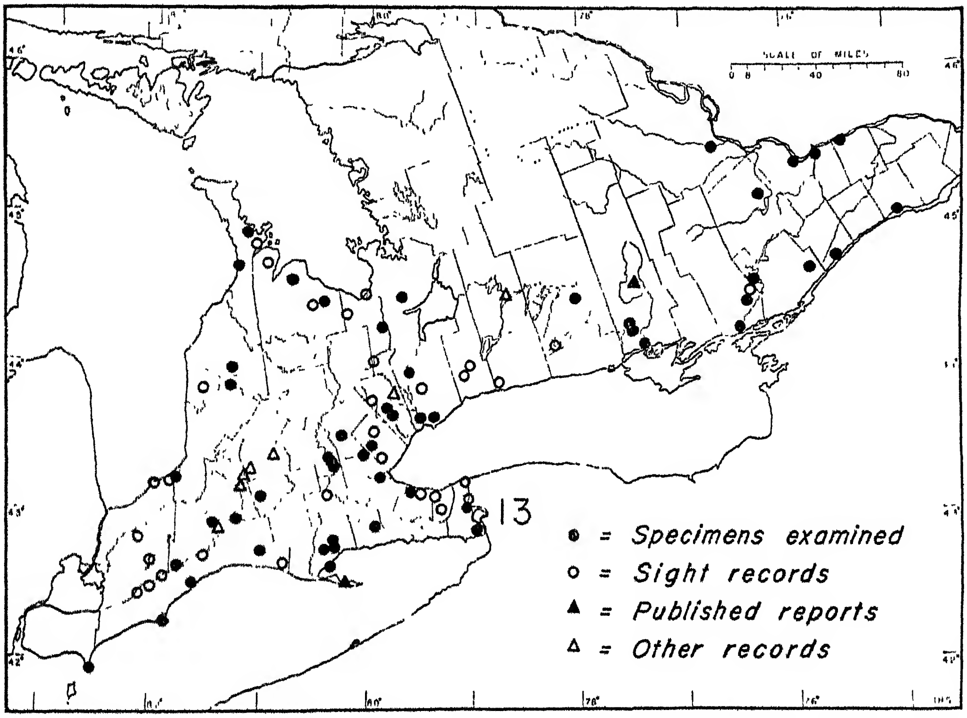

FIG. 14. Distribution of Butternut (*Juglans cinerea*).

BRANT: lot 31, conc. III, Brantford Tp., June 22, 1950, *J. H. Soper* (s.r.). BRUCE: rocky hardwoods, Hope Bay, Aug. 26, 1935, *P. Krotkov 9768* (TRT); river bank, near mouth of Sauble River, Aug. 1, 1934, *R. F. Cain* (TRT); Teeswater, May 28, 1886, *Jennie Farrell* (QU); near Purple Valley, June 5, 1950, *J. H. Soper* (s.r.). CARLETON: deciduous woods along east side of Rideau River, near Ottawa, Mar. 19, 1947, *C. Frankton et al. 541* (DAO); open woods, one mile south of South March, May 24, 1946, *H. Lloyd* (DAO). DURHAM: lot 27, conc. III, Darlington Tp., June 13, 1950, *J. H. Soper* (s.r.). ELGIN: rich woods, Aylmer, June 9, 1898, *R. T. Anderson* (TRT); Aldborough, May 1878, *D. Currie* (McG); lot 17, conc. I, Dunwich Tp., July 22, 1948, *J. H. Soper* (s.r.); on Otter River near Vienna, Oct., 1950, *W. S. Fox* (s.r.). ESSEX: Point Pelee, June 11, 1916, *M. O. Malte* (CAN). FRONTENAC: Tuttle's Hill [near Kingston], June 10, 1893, *Alex. H. D. Ross* (QU); Battersea, May 28, 1904, *ex herb. J. Fowler* (QU); on Lower Rock Lake, June 22, 1952, *J. H. Soper* (s.r.). GRENVILLE: near Prescott, 1860, *B. Billings* (QU). GREY: Woodford, June

12, 1932, *H. H. Brown* (TRT); Redwing, June 12, 1932, *H. H. Brown* (TRT); lot 15, conc. V, Euphrasia Tp., Aug. 11, 1952, *J. H. Soper* (s.r.); near Lindenwood, June 6, 1952, *J. H. Soper* (s.r.). HALDIMAND: 2 miles northeast of Nelles Corners, July 5, 1951, *Bert Miller 398* (McM). HALTON: Crawford Lake, Sept. 30, 1948, *L. A. Feaver* (McM); Mt. Nemo, May 21, 1952, *J. H. Soper* (s.r.); lot 14, conc. III, Esquesing Tp., Aug. 7, 1948, *J. H. Soper* (s.r.). HASTINGS: vicinity of Belleville, May 24, 1873, *J. Macoun* (TRT); in rich woods, Oak Hills, June 10, 1877, *J. Macoun* (CAN); roadside, Chatterton, July 13, 1939, *W. H. Minshall 608* (DAO); Hasard's Corners, Madoc Tp.—Harrington (27): this locality is north of the contact line between the Ordovician to the south and the Precambrian Shield to the north. The record is therefore one of the exceptions noted above where Butternut appears to be within the Shield area. It is interesting to note, however, the comment made by Harrington (loc. cit., p. 316) concerning the habitat of the Butternut in Madoc Tp.: "This was the only place in which this tree was met with during the summer, and the reason of its occurrence here is probably to be found in the deposits of drift which form a richer soil than that derived from the wear of the metamorphic rocks." Our original observation regarding the general absence of Butternut on the Canadian Shield is hereby supported by the appearance of a plausible explanation for an apparent exception. It would be interesting to have information concerning the local geological conditions and soil types for the other few apparent exceptions. HURON: Wingham, June 1894, *J. A. Morton* (WO); lot 44, conc. VI, W. Wawanosh Tp., Aug. 9, 1941, *J. H. Soper* (s.r.). KENT: Rondeau Park, May 29, 1905, *J. H. Faull* (TRT); lot 18, conc. II, Harwich Tp., Aug. 12, 1941, *J. H. Soper* (s.r.); lots 7 & 10, River Range, Howard Tp., June 24–25, 1950, *J. H. Soper* (s.r.); lot 6, conc. VIII, Zone Tp., June 25, 1950, *J. H. Soper* (s.r.). LAMBTON: sandy field near Lake Smith, July 18, 1940, *J. H. Soper et al. 2199* (DAO); near Port Franks, June 20, 1948, *J. H. Soper* (s.r.); Kettle Point, Aug. 10, 1941, *J. H. Soper* (s.r.); lot 15, conc. VII, Enniskillen Tp., Aug. 10, 1941, *J. H. Soper* (s.r.); lot 24, conc. XIV, Dawn Tp., Aug. 12, 1941, *J. H. Soper* (s.r.). LANARK: Ramsay, 1862, *J. K. McMorine* (QU). LEEDS: oak woods, vicinity of Lake Opinicon, July, 1952, *J. K. Shields s.n.* (TRT); Elizabethtown, May, 1887, *T. G. Allen* (QU). LINCOLN: Beamer's Falls, N. Grimsby Tp., May 21, 1952, *Bert Miller 124* (McM); Three-Mile Creek near Niagara-on-the-Lake, Aug. 12, 1952, *J. H. Soper* (s.r.); lot 19, conc. III, Louth Tp. & lot 18, conc. IV, Clinton Tp., July 4, 1950, *J. H. Soper* (s.r.). MIDDLESEX: river bank, London, May 20, 1880, *T. J. W. Burgess* (McG); low ground near Komaka, May 19, 1929, *J. F. Calvert* (JFC); Wardsville, June 5, 1893, *N. D. Keith* (McG); lot 35, conc. II, Nissouri W. Tp., July 20, 1950, *J. K. Shields* (s.r.); conc. III, Delaware Tp., July 27, 1950, *J. K. Shields* (s.r.). NORFOLK: Walsh, May 21, 1933, *H. H. Brown* (TRT); Simcoe, June 18, 1950, M. Landon (MI.); low ground along stream, about 4 miles northwest of Port Ryerse, July 13, 1940, *J. H. Soper 2093* (DAO, McM); mixed woods, Turkey Point, May 21, 1933, *T. M. C. Taylor* (TRT); Long Point—Snyder (40). ONTARIO: between Glen Major and Chalk Lake, Aug. 6, 1950, *M. L. Heimburger* (s.r. JHS); lot 15, conc. VII, Pickering Tp., June 9, 1950, *J. H. Soper* (s.r.). OXFORD: edge of woods about 5 miles north of Thamesford, May 30, 1950, *Soper & Shields 4515* (TRT). PEEL: Snelgrove, June 1 & July 22, 1908, *J. White* (TRT); Brampton, June 6, 1888, *T. L. Walker* (QU); lot 4, conc. III W., Caledon Tp., June 5, 1952, *J. H. Soper* (s.r.): 6 miles southeast of Albion, *Mrs. Stanley Davidson* (s.r.). PERTH: lot 33, conc. VIII, Easthope N. Tp., July 21, 1950, *J. K. Shields* (s.r.); near St. Marys, July 26, 1950, *J. K. Shields* (s.r.); lot 19, conc. XII, Downie Tp., July 26, 1950, *J. K. Shields* (s.r.). PETERBOROUGH: rocky roadside, 2 miles west of Centre Dummer, June 11, 1948, *Soper & Dale 3890* (DAO, TRT); mouth of Otonabee River, June 12, 1948, *J. H. Soper* (s.r.). RENFREW: Renfrew, June, 1906, *O. Stewart* (QU). RUSSELL: hillside at edge of creek flats, 3 miles east of Cumberland, July 4, 1947, *Cody & Calder 536* (DAO). SIMCOE: Camp Borden, Sept. 4, 1950, *H. F. Calvert* (JFC); Dalston, July 30, 1949, *H. H. Brown* (TRT); lot 20, conc. II-III, Adjala Tp., June 28, 1950, *J. H. Soper* (s.r.); near Singhampton, June 29, 1950, *J. H. Soper* (s.r.); near mouth of Nottawassaga River, June 29, 1950, *J. H. Soper* (s.r.). STORMONT: one mile southwest of Wales, July 8, 1953, *Dore & Gillett 14431* (DAO, TRT). VICTORIA:

Sturgeon Point, June 6, 1953, report of Peterborough Nature Club in Nature News, June, 1953. WATERLOO: flats of the Grand River above Galt, May 5, June 13, & Oct. 18, 1940, *F. H. Montgomery 565* (DAO, McM, OAC); Preston, Dec. 1, 1946, *W. J. Lamoureux* (NPC); west river bank at the first island below Galt, July 20, 1893, *W. Herriot* (OAC). WELLAND: sandy soil over limestone, lot 6, conc. IX, Bertie Tp., June 10, 1950, *Bert Miller 51* (McM, TRT); Niagara Falls, June 28, 1897, *W. Scott* (CAN); Niagara Glen, July 30, 1940, *J. H. Soper* (s.r.); lot 2, conc. V, Pelham Tp., June 27, 1941, *J. H. Soper* (s.r.). WELLINGTON: Guelph, June 20, 1942, *W. G. Evans* (OAC). WENTWORTH: Hamilton, 1933, *R. W. Smith* (McM); open land on edge of woods, conc. XII, East Flamborough Tp., May 11, 1941, *L. O. Gaiser* (McM). YORK: Pottageville, Nov. 20, 1938, *L. T. Owens* (TRT); Toronto, June 4, 1936, *M. D. Kirk* (MDK); Lambton, Feb. 5, 1939, *J. Simon* (TRT); near Maple, May 4, 1952, *M. L. Heimburger* (s.r. JHS).

14. *Juglans nigra* L.—BLACK WALNUT.

The range of the Black Walnut in eastern North America may be taken as that of a typical Carolinian tree. Its range is practically the same as that of the Sassafras; the closeness of this correspondence is particularly noticeable in southern Ontario. Fortunately, through the precise field notes of surveyors such as Mahlon Burwell (ca. 1809–1810), the careful papers of the Moravian missionaries and the casual remarks of travellers like Pope and Lundy, we know the status of this species in Ontario's primeval forest. Unlike oaks and pines, it did not grow in solid stands but scattered among the other woodland trees whose decayed leaves provided the kind of mulch needed to make it thrive. This explains the failure of attempts to cultivate our Walnut in orderly plantations, a method most successful in the case of certain conifers. Any large Black Walnut now found north of a line drawn from Grand Bend to Toronto may be regarded as planted by man or by that most random of planters, the squirrel. So ruthless were our pioneers in their treatment of this valuable tree that Canadian furniture manufacturers must import from the Appalachian highlands practically all their logs for the making of fine walnut veneer.

The locations of the stations for Black Walnut in Ontario are shown on the map, Fig. 15, that is based on the following records:

BRANT: along the river [Grand] at Paris—Herriot (28). ELGIN: St. Thomas, July 13, 1907, *J. Macoun* (CAN). ESSEX: at Point Pelee and on Pelee Island—Dodge (7); near Malden Centre, July 27, 1948, *J. H. Soper* (s.r.); near Kingsville, June 10, 1953, *J. K. Shields* (s.r.); 5 miles northeast of Amherstburg, June 22, 1953, *J. K. Shields* (s.r.); near LaSalle, June 23, 1953, *J. K. Shields* (s.r.). HALDIMAND: one mile south of York on Grand River, June 1, 1951, *Bert Miller 188* (McM). KENT: lot 10, River Range, Howard Tp., June 24–25, 1950, *J. H. Soper* (s.r.); Mitchell Bay, Aug. 11, 1941, *J. H. Soper* (s.r.). LAMBTON: along moist ditch, Lake Smith, June 10, 1934, *L. O. Gaiser* (McM); on the west side of the Sydenham River valley west of Florence, *W. S. Fox* (s.r.); near Thedford, Aug., 1946, *W. S. Fox* (s.r.). LINCOLN: Queenston, June 3, 1899, *Wm. Scott* (TRT); Three-Mile Creek near Niagara-on-the-Lake, Aug. 12, 1952, *J. H. Soper* (s.r.). MIDDLESEX: low ground near Komoka, June 1, 1929, *J. F. Calvert* (JFC); [2 miles west of] London, May 25 & June 7, 1884, *T. Millman* (TRT); London, June 10, 1881, *T. J. W. Burgess* (McG); Pond Mills, Westminster Tp., July 19, 1950, *J. K. Shields* (s.r.); 3 miles south-east of Parkhill, June 25, 1943, *W. S. Fox* (s.r.). NORFOLK: about 4 miles northwest of Port Ryerse, July 13, 1940, *J. H. Soper 2096* (DAO, McM); lot 12, Woodhouse Gore, May 17, 1949, *M. Landon* (ML); Long Point—Snyder (40).

OXFORD: lot 7, conc. XII, Dereham Tp., June 26, 1950, *J. H. Soper* (s.r.); between Woodstock and Norwich—Lundy (33). PEEL: Elmbank, Sept., 1911, *J. White* (FFT). WATERLOO: dry woods one mile south of Kitchener, May 29, 1940, *F. H. Montgomery 564* (DAO, McM, OAC); Preston—Montgomery (36). WELLAND: near the Whirlpool, Niagara River, July 18, 1897, *Wm. Scott* (CAN); Miller's Creek, Bertie Tp., June 8, 1950, *Bert Miller 38* (McM); Morgan's Point, June 15, 1950, *J. Evel* (McM); Niagara Falls, June 28, 1897, *Wm. Scott* (TRT); Pleasant Beach, near Point Abino, Sept. 6, 1941, *J. H. Soper* (s.r.). WENTWORTH: West Hamilton, May 15, 1934, *C. Gompf* (McM). YORK: woods, vicinity of Toronto, May 24, 1938, *M. D. Kirk* (MDK).

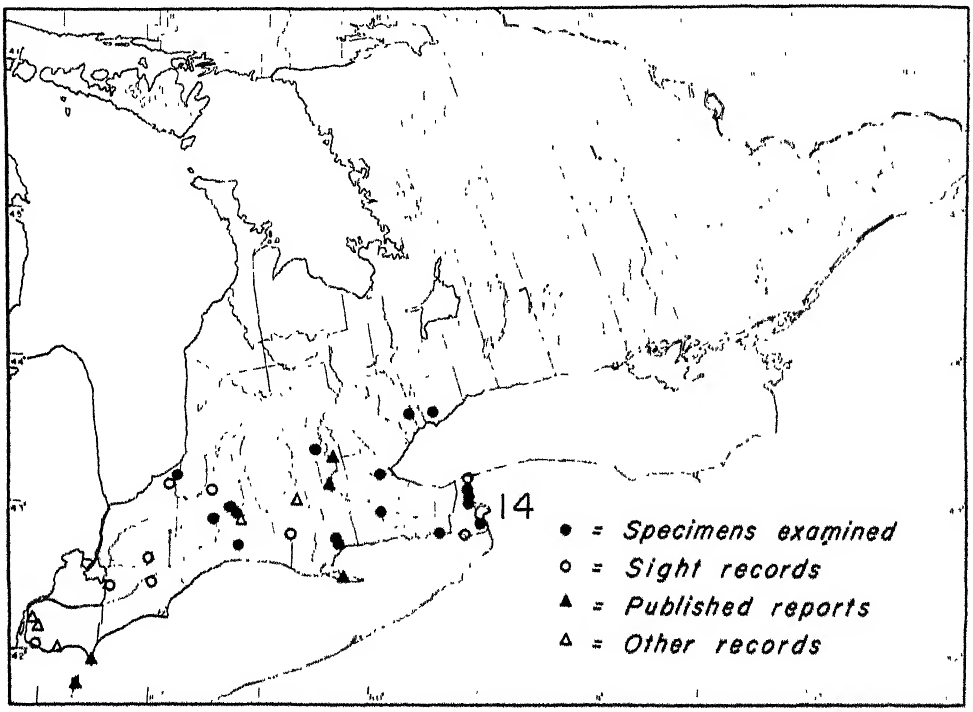

FIG. 15. Distribution of Black Walnut (*Juglans nigra*).

FAGACEAE—Beech Family

15. *Castanea dentata* (Marsh.) Borkh.—AMERICAN CHESTNUT, SWEET CHESTNUT.

Gone, with no prospect of recovery yet in sight, from the eastern United States and southern Ontario is one of the most beautiful and useful of native trees, killed by a ruthless, insidious alien fungus disease. Occasionally on the sites of once strong Ontario stands one still finds young trees that have sprung up from old dead roots and have survived long enough to bear a few nuts; sometimes seedlings from these are known also to reach the stage of fruit-bearing.

However no one has discovered, as yet, among such seedlings and sucker growths, any that is resistant to the blight.

It is significant that the distribution of the Chestnut in southern Ontario (Fig. 16) is practically the same as for other so-called typical Carolinian species—Flowering Dogwood, Sassafras and Tulip-Tree. Here, as in New England, seldom

have specimens of these trees appeared north of latitude 43° 30′.
which the map is based are as follows:

BRANT: roadsides east of Glen Morris, *R. M. Lewis* (WO); Hatchley—Macoun (12); Burford, July, 1885, *Wm. Yates* (s.r.). ELGIN: Springwater, Malahide Tp., Aug. 24, 1941, *D. Young* (TRT); sandy woodland, Talbotville, July 3, 1881, *J. A. Balkwill* (McG); lot 12, conc. III, Yarmouth Tp., July 18, 1941, *J. H. Soper* (s.r.); south of Wardsville in Aldborough Tp., *H. L. Lancaster* (corr. W.S.F.). ESSEX: sandy woods, Leamington, Aug. 16, 1886, *T. J. W. Burgess* (McG); open woods along Cedar Creek, southwest of Kingsville, June 25,

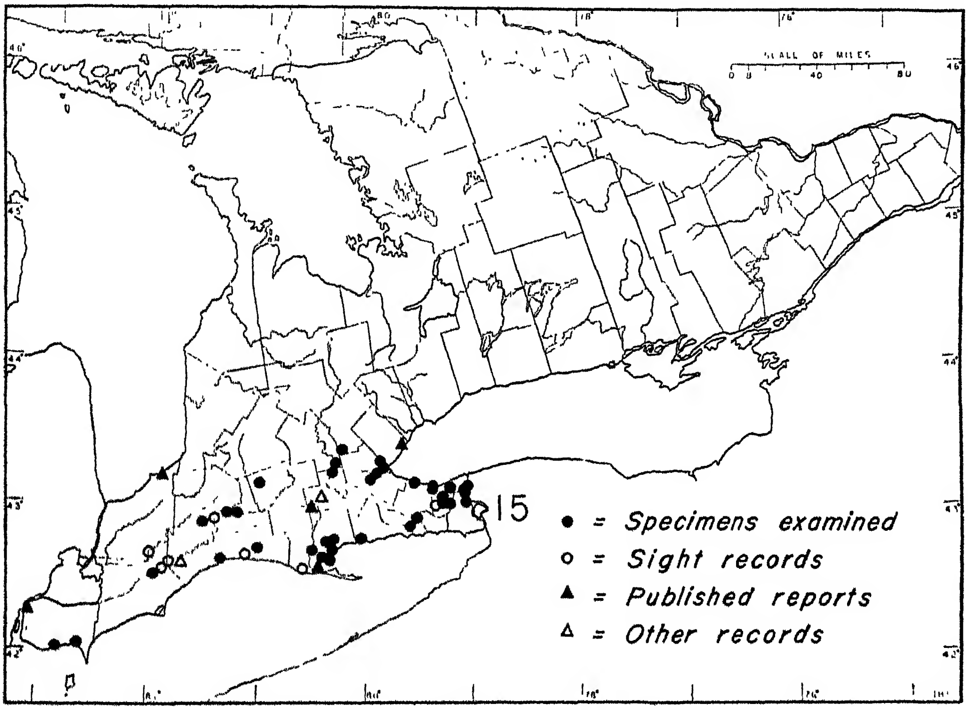

Fig. 16. Distribution of Sweet Chestnut (*Castanea dentata*).

1953, *J. K. Shields 1441* (TRT); in woods about Windsor—Dodge (7). HALDIMAND: Nanticoke, 1936, *L. Werner* (McM); 2 miles east of Dunnville, July 3, 1951, *Bert Miller 317* (McM); 2 miles east of Moulton Station, Sept. 6, 1951, *Bert Miller 639* (McM). HALTON: Oakville—Fox (24). KENT: Thamesville, July 19, 1928, *R. F. Cain* (RFC); lot 6, conc. VIII, Zone Tp., June 25, 1950, *J. H. Soper* (s.r.). LAMBTON: lot 24, conc. XIV, Dawn Tp., Aug. 12, 1941, *J. H. Soper* (s.r.); Port Franks—Fox (24). LINCOLN: Grimsby, July 3, 1927, *H. H. Brown* (TRT); about 2 miles south of Vineland, Aug. 13, 1952, *J. H. Soper 5808* (TRT); near St. Davids, Oct. 9, 1952, *Bert Miller 803* (McM); St. Catharines, Sept., 1915, *J. H. White* (FFT). MIDDLESEX: Byron, Oct. 12, 1942, *W. S. Fox* (WO); London, July 1, 1880, *H. & P. Saunders* (DAO); west of Mt. Brydges, July, 1944, *W. S. Fox* (WO); lot 24, conc. II, Mosa Tp., Aug. 12, 1941, *J. H. Soper* (s.r.); north side of Thames River, 1925, *W. S. Fox* (s.r.). NORFOLK: Fisher's Glen, *T. J. Ivey* (TRT); rich woods, Turkey Point, June 28, 1938, *J. H. Soper 255* (McM); Ambrose, May 24, 1937, *H. H. Brown* (TRT); dry sandy land, Walsingham, June 28, 1944, *W. G. Dore 44–29* (DAO); St. Williams, July 3, 1936, *Fr. Marie-Victorin et al. 46376* (CAN, DAO, MT, TRT); lot 17, conc. VI, Charlotteville Tp., June 25, 1941, *J. H. Soper 2622* (TRT); lots 1–2, conc. III, Walsingham Tp., Aug. 20, 1952, *J. H.*

(s.r.); Port Rowan—Snyder (40). OXFORD: Lakeside, Oct. 22, 1947, *W. S. Fox*). WATERLOO: dry wooded slopes of Grand River, 5 miles south of Galt, July 1, 1942, *. H. Montgomery* (WO). WELLAND: Niagara Falls, July 10, 1898, *Wm. Scott* (TRT); dry sandy soil, Stamford Tp., Sept. 30, 1948, *Bert Miller 827* (McM); Fonthill, Sept. 23, 1948, *Bert Miller 775* (McM); southwest of DeCew Falls, July 5, 1950, *J. H. Soper et al. 4900* (TRT); lot 15, conc. VIII, Pelham Tp., May 23, 1951, *J. H. Soper* (s.r.). WELLINGTON: near Puslinch Lake, May 20, 1940, *R. M. Lewis* (WO). WENTWORTH: beech woods, LaSalle Park, Hamilton, Aug. 5, 1940, *J. H. Soper 2296* (DAO, GH); Waterdown Ravine,

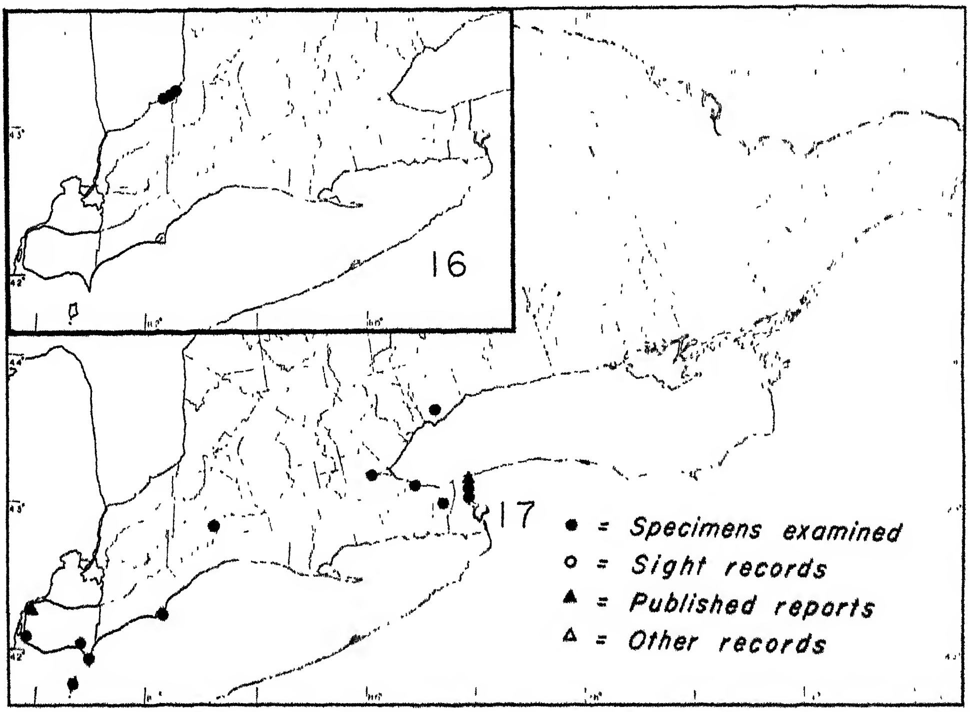

FIG. 17. Map 16: Distribution of Dwarf Hackberry (*Celtis tenuifolia*).
Map 17: Distribution of Red Mulberry (*Morus rubra*).

J. M. Dickson (McMHA); West Hamilton, June 13, 1932, *H. A. Senn* (McM); lot 47, conc. III, Ancaster Tp., July 4, 1948, *W. W. Judd 128* (WWJ).

EXCLUDED RECORD: "plentiful in the vicinity of Toronto (A. Fowler)" according to Macoun (12). This record has not been plotted since the exact site is not given and no other reports for Toronto have been seen. The locality may have been as far west as Oakville, whence it has been reported by several observers.

ULMACEAE—Elm Family

16. *Celtis tenuifolia* Nutt.—DWARF HACKBERRY.

This shrub or tiny tree is exceedingly interesting by reason of its great rarity and its appearance. It is found in Ontario only on the very limited tract of sand flats and dunes east and south of the last reach of the Aux Sables River in the northeast corner of Lambton County. There it is found growing among tall mature specimens of its close relative, the Hackberry. Mature examples of the dwarf

species heavily laden with fruit and growing on the slopes and peaks of sand dunes up to seventy-five feet in height are well known to the authors of this paper.

The range of this species is shown on map 16, Fig. 17, and the records include the following:

LAMBTON: in sandy oak-pine woods, near Port Franks, June 20, 1948, *Soper & Dale s.n.* (TRT); on large sandhill with southern exposure, about eight miles south of Grand Bend, July 18, 1940, *J. H. Soper et al. 2200* (DAO, McM).

MORACEAE—Mulberry Family

17. *Morus rubra* L.—RED MULBERRY.

Because of their association with the silkworm both species of Mulberry, Red and White, are popularly regarded as having been brought in from the eastern world. Actually, the Red is native to Ontario, whereas the White is the exotic. The range of wild trees of the Red Mulberry, as compared with those which have obviously been planted by man, falls just a little short of the northern limit for the Walnut and the Sassafras. Specimens are few and widely scattered. This species seems to be extending its range slowly northward through the agency of birds.

Red Mulberry is found on sandy soil, in low rich woods or occasionally in woods on rocky ground. The records are shown on map 17, Fig. 17, and are listed below:

ESSEX: sandy ridges along Lake Erie shore, west side of Point Pelee, Aug. 29, 1940, *J. H. Soper 2453* (DAO, McM); Pelee Island, July 27, 1892, *J. Macoun* (CAN); Leamington, July 1, 1882, *T. J. W. Burgess* (McG); Amherstburg, June 12, 1882, *J. Macoun* (QU); Windsor—Macoun (12). KENT: woods on sandy soil, Rondeau Provincial Park, Aug. 15, 1940, *J. H. Soper 2365* (DAO, McM). LINCOLN: rich moist woods, Grimsby, May 15, 1943, *T. H. Norris* (McM); Queenston Heights, May 26 & Aug. 2, 1897, *W. C. McCalla* (CAN); between Brock's Monument and Paradise Grove—Hamilton (26). MIDDLESEX: rich woods, South Delaware, June 5, 1928, *Mrs. Brock Olde* (WO). WELLAND: rocky land, Niagara Gorge, June 8, 1948, *Bert Miller* (McM); near Fonthill, May 8, 1942, *F. T. Knapp* (McM). WENTWORTH: Dundas Mountain, May 24, 1902, *Jas. E. Kerr* (OAC). YORK: rich woods, Toronto [possibly the result of a fortuitous introduction], June 27, 1941, *D. W. Kirk* (MDK).

HAMAMELIDACEAE—Witch-Hazel Family

18. *Hamamelis virginiana* L.—WITCH-HAZEL.

The Witch-Hazel belongs to nearly all the eastern half of the United States and a region that includes southern Quebec and Nova Scotia. Its range in Ontario corresponds, in the main, to that of the Sassafras; occasional stations have been reported east of Toronto near Lake Ontario, at the head of the St. Lawrence (where it is quite abundant), near Ottawa, and close to the southern tip of Georgian Bay.

This shrub flourishes in a variety of habitats in Ontario, both in dry and in damp situations, in sandy or rocky woods, and on the slopes of wooded ravines. Occasionally (as along Lake Erie near Wheatley) it forms dense thickets in almost pure stands. The distribution is shown in Fig. 18, and the records include the following:

BRANT: about 3 miles southeast of Glen Morris, May 27, 1950, *Soper & Shields 4443* (TRT); 2 miles west of Brantford, June 20, 1943, *T. H. Norris* (McM); lot 27, conc. V, Tuscarora Tp., May 28, 1950, *J. H. Soper* (s.r.); lot 31, conc. III, Brantford Tp., June 22, 1950, *J. H. Soper* (s.r.); lot 15, conc. IV, Dumfries S. Tp., June 26, 1950, *J. H. Soper* (s.r.). CARLETON: thickets, Ottawa, Sept. 5, 1891, *Wm. Scott* (OAC): reported by Fletcher (23) as follows: "Thickets. Very rare at Ottawa. The only locality being on the Chelsea Road about 2 miles from Hull, where there are a few bushes." It is possible that the specimen collected by Scott and cited above may have been from the locality (in Quebec) described by Fletcher. No other specimens from the Ottawa district have been seen by the authors of this paper and this species may be extinct as a native plant in that area. DUFFERIN: near Mansfield, Autumn, 1953, *C. Heimburger & A. Leslie* (s.r.). ELGIN: Aylmer, Oct. 12, 189[8], *R. T. Anderson* (TRT);

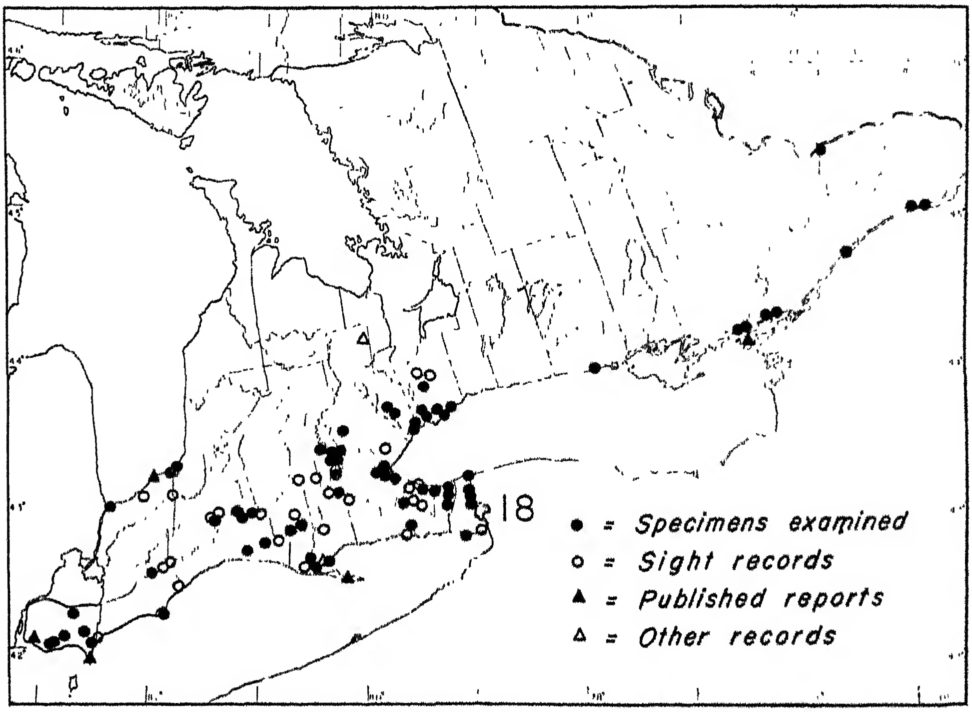

FIG. 18. Distribution of Witch-Hazel (*Hamamelis virginiana*).

Jolley's Swamp, S. Yarmouth Tp., Aug. 4, 1941, *Donald Young* (TRT); lot 15, conc. IX, Bayham Tp., May 29, 1950, *J. H. Soper* (s.r.). ESSEX: southeast of Staples, June 9, 1953, *J. K. Shields 1205* (TRT); southeast of Harrow, June 12, 1953, *J. K. Shields 1265* (TRT); northeast of South Woodslee, June 13, 1953, *J. K. Shields 1285* (TRT); southwest of Wheatley, June 19, 1953, *J. K. Shields 1335* (TRT); northwest of Kingsville, June 27, 1953, *J. K. Shields 1451* (TRT); Point Pelee—Dodge (7); Malden (*Maclagan*)—Macoun & Gibson (35). FRONTENAC: Kingston, Sept., 1895, *J. K. McMorine* (DAO); hemlock-birch woods, Eastview, Oct. 11, 1946, *J. M. Gillett 1021* (DAO); rocky hillside, 6 miles west of Gananoque, Oct. 9, 1945, *Senn & Zinck 2281* (DAO); Wolfe Island—Macoun & Gibson (35). GRENVILLE: thickets near Prescott Junction, Autumn, 1860, *B. Billings* (QU). HALDIMAND: 2 miles east of Dunnville, May 17, 1951, *Bert Miller 14* (McM); between Grant Point and Low Point, Aug. 2, 1941, *J. H. Soper* (s.r.). HALTON: lot 5, conc. II, Nelson Tp., May 22, 1951, *J. H. Soper* (s.r.). HASTINGS: [without definite locality] Sept. 15, 1873, *J. Macoun* (McG);

reported as "scarce in Hastings and Northumberland Cos., Ont. (Macoun)"—Macoun (12). KENT: in mixed hardwood forest, Rondeau Provincial Park, Aug. 15, 1940, *J. H. Soper 2390* (GH); roadside woods near Thamesville, July 26, 1944, *W. G. Colgrove* (DAO, WO); near Clearville, July 27 28, 1948, *J. H. Soper* (s.r.); near Wheatley, Aug. 3, 1950, *J. H. Soper* (s.r.), lot 6, conc. VIII, Zone Tp., June 25, 1950, *J. H. Soper* (s.r.). LAMBTON: Grand Bend, Aug. 1, 1900, *H. S. Saunders* (TRT); dry sandy oak-pine woods, about 4 miles northeast of Port Franks, Aug. 1, 1950, *Soper & Shields 5032* (TRT); Sarnia, July 11, 1911, *M. O. Malte* (CAN); Arkona Rock Glen, Aug. 6, 1950, *J. H. Soper* (s.r.); 2 miles north of Aberarder, Sept. 29, 1952, *M. L. Heimburger* (s.r. JHS). LEEDS: Gananoque, Aug. 14, 1883, *J. Fowler* (QU). LINCOLN: one mile west of DeCew Falls, Aug. 26, 1952, *Bert Miller 730* (McM); Niagara-on-the-Lake, May 28, 1943, *R. S. Haines* (McM); thickets, near St. Catharines, July 10 & Oct., 1897, *W. C. McCalla* (CAN); Vineland, June 22, 1940, *H. M. Harrison* (OAC); Beamsville, 1919, *W. Stewart* (QU); 2 miles west of Queenston, Oct. 22, 1952, *Bert Miller 821* (McM); one mile southwest of Caistor Centre, Aug. 13, 1952, *J. H. Soper 5819* (TRT); about 2 miles northeast of Bismark, Aug. 13, 1952, *J. H. Soper* (s.r.); lot 39, conc. VI, Gainsborough Tp., June 17, 1950, *J. H. Soper* (s.r.); lot 2, conc. II, N. Grimsby Tp., May 22, 1951, *J. H. Soper* (s.r.); lot 19, conc. VII, S. Grimsby Tp., June 19, 1950, *J. H. Soper* (s.r.). MIDDLESEX: woods, London, May 14, 1899, *H. S. Saunders* (TRT); dry woods, Westminster Ponds, *T. J. W. Burgess* (DAO); Dorchester, Oct. 12, 1940, *H. B. Hitchcock* (WO); near Mt. Brydges, July 19, 1950, *J. K. Shields 116* (TRT); near Putnam, May 29, 1950, *J. H. Soper* (s.r.); lot 10, conc. I, Lobo Tp., June 24, 1950, *J. H. Soper* (s.r.); lot 1, conc. II, Lobo Tp., July 18, 1941, *J. H. Soper* (s.r.); lot 24, conc. II, Mosa Tp., Aug. 12, 1941, *J. H. Soper* (s.r.). NORFOLK: wooded ravine along shore, Turkey Point, July 6, 1938, *J. H. Soper 302* (McM); Port Rowan, July 31, 1937, *W. S. Fox* (WO); dry sandy land, Walsingham, June 28, 1944, *W. G. Dore 44 28* (DAO); lot 9, conc. XI-XII, Windham Tp., May 28, 1950, *J. H. Soper* (s.r.); lots 1 2, conc. III, Walsingham Tp., Aug. 20, 1952, *J. H. Soper* (s.r.); St. Williams, July 3, 1936, *Fr. Marie-Victorin et al.* (s.r.); Long Point—Snyder (40). NORTHUMBERLAND: in thickets and open woods, near Colborne, July 20, 1867, *J. Macoun* (CAN). OXFORD: damp woods, Cornell, Sept. 23, 1927, *R. F. Cain* (RFC); Tillsonburg, May 29, 1950, *Soper & Shields 4479* (TRT); lot 2, conc. VI, Blandford Tp., and lot 2, conc. V, Blenheim Tp., June 23, 1950, *J. H. Soper* (s.r.); lot 25, conc. III, N. Norwich Tp., June 14, 1953, *L. Stock* (s.r. JHS). PEEL: thickets, Port Credit, June 14, 1902, *A. Cosens* (TRT); Summerville, Oct. 20, 1929, *H. H. Brown* (TRT); hillsides, Brampton, Sept. 20, 1902, *A. Cosens* (TRT); Snelgrove, Oct. 26, 1909, *J. White* (TRT). STORMONT: Sheek Is., July 7, 1953, *Dore & Gillett 14410* (DAO, TRT); Cornwall Is., Aug. 25, 1953, *J. M. Gillett 8002* (DAO, TRT). WATERLOO: Dickson's Woods, [Galt], Oct. 10, 1900, *R. S. Hamilton* (OAC); dry river bank, German Mills, Oct. 13, 1940, *F. H. Montgomery 612A* (DAO, McM, OAC); Preston, July 1, 1949, *H. Groh* (DAO); Orr's Lake, west of Galt, Aug. 17, 1940, *F. H. Montgomery 1131* (OAC). WELLAND: sandy soil, Fonthill, Oct. 23, 1948, *Bert Miller 908* (McM); sandy soil, Point Abino, Oct. 15, 1948, *Bert Miller 903* (McM); Lundy's Lane [Niagara Falls], May 14, 1902, *J. Voaden* (QU); Whirlpool, Niagara River, Apr. 26, 1902, *J. Voaden* (QU); Rosehill, May 21, 1950, *J. H. Soper* (s.r.). WELLINGTON: woods, Puslinch Lake, Oct., 1931, *E. G. Anderson* (OAC); rich woods, Guelph, June 10, 1937, *J. J. Stroud* (TRT). WENTWORTH: gravelly soil at foot of mountain, Hamilton, Aug. 9 & Oct. 10, 1888, *T. J. W. Burgess* (McMHA); near mouth of Stoney Creek, Oct. 12, 1947, *W. J. Cody 992* (DAO); Cootes Paradise, Hamilton, Sept. 13, 1898, *F. P. Clappison* (TRT); dry woods between Aldershot and Waterdown, June 16, 1950, *Soper & Shields 4675* (TRT). YORK: shady valley, Mount Dennis, Sept. 19, 1915, *N. H. C. Ford* (TRT); vicinity of Toronto, Oct. 10, 1879, *J. Macoun* (CAN); Scarborough, Oct. 10, 1929, *Estelle Nelles* (TRT); Lawrence Heights, Toronto, Oct. 8, 1940, *D. W. Kirk* (MDK); Humber River at Bloor Street, Apr. 6, 1935, *H. H. Brown* (TRT); east bank of ravine, near Maple, Oct. 11, 1952, *M. L. Heimburger* (TRT); lot 18, conc. VI, King Tp., June 28, 1950, *J. H. Soper* (s.r.); lot 60, conc. I, Markham Tp., Aug. 5, 1948, *J. H. Soper* (s.r.).

EXCLUDED RECORD: "Wasaga Beach, comté de Simcoe: Port Francis, bois sablonneux,

6 juillet 1936, *Fr. Marie-Victorin, Fr. Rolland-Germain, Fr. Dominique 16, 1937* (DAO, MT, TRT). The authors have been unable to locate a Port Francis at or near Wasaga Beach (on Georgian Bay) but it is known that Frere Marie-Victorin was collecting in the vicinity of Grand Bend and Port Franks (on lake Huron) on July 6th, 1936. *Hamamelis virginiana* is common in the "Pinery" along the shore of Lake Huron from Grand Bend south to Port Franks and beyond whereas no other reports have been found of the occurrence of this species on the shores of Georgian Bay.

ROSACEAE—Rose Family

19. *Pyrus coronaria* L. (incl. var. *dasycalyx* (Rehd.) Fern.)—WILD CRAB, AMERICAN WILD CRAB, SWEET-SCENTED CRAB.

From South Carolina to southwestern Ontario this tree is quite common in neglected fence rows and on the borders of untended woodlots, but it is popularly regarded as a domestic apple which has reverted to the wild state rather than as a native living in its natural habitat. In our Province its home is that, for example, of the Sassafras and Flowering Dogwood. Though rough and forbidding in mid-winter, in early summer its beautiful shell-pink fragrant blossoms and its strangely lobed leaves and in Autumn its little green wax-coated apples, make it one of the distinctive trees of the countryside. From its acrid apples the early colonists made a cider the harsh qualities of which caused Francois Michaux to pity Americans for their ignorance of the famous product of the orchards of Normandy. It is of these apples that, in the late seventeenth century, the loquacious Baron de Lahontan wrote that they "eat well when they are Codled, but they are good for nothing when they are Raw."

The range of the wild crab is shown in Fig. 19 and the records on which the map is based are as follows:

BRANT: dry woods along the Grand River, lot 24, conc. VI, Tuscarora Tp., May 28, 1950, *Soper & Shields 4453* (TRT); Pleasant Ridge, Aug. 28, 1942, *R. F. Cain* (TRT); near New Durham, June 1953, *R. F. Cain* (s.r.). ELGIN: open sandy woods near St. Thomas, May 29, 1950, *L. E. James* (DAO); Aldborough—Macoun (12). ESSEX: swamps near Amherstburg June, 1882, *J. Macoun* (CAN); in thickets near Leamington, May 30 & June 17, 1901, *J. Macoun* (TRT); Malden (*Maclagan*)—Macoun (12). HALTON: Lake Medad (*Logie*)—Macoun (12). KENT: open woods, Kent [Centre?], May 24, 1931, *A. J. S. Gesner* (OAC); woods, Wallaceburg, June 17, 1901, *J. Macoun* (CAN); Rondeau Provincial Park, May 29, 1953, *R. D. Ussher* (TRT); sandy soil east of Rondeau Park, Aug. 14, 1934, *R. F. Cain* (TRT); around Romney, *Mrs. R. W. Leader* (corr. W.S.F.). LAMBTON: along roadside in the Pinery about 6 miles south of Grand Bend, Sept. 16, 1953, *Soper & Dale 16B-20* (TRT); Walpole Island, Aug. 26, 1938, *L. O. Gaiser* (McM); Kettle Point, Lake Huron (*Gibson*)—Macoun (12); about 2 miles south of Grand Bend, *W. S. Fox* (s.r.). LINCOLN: vicinity of Queenston Heights, July 27, 1877, *J. Macoun* (OAC); Beamsville, May 24, 1930, *H. H. Brown* (TRT); St. Catharines, May 21, 1891, *Wm. Scott* (CAN); near DeCew Falls—Zenkert (14). MIDDLESEX: London, May 20, 1879, *T. J. W. Burgess* (CAN); Byron, July 26, 1944, H. Groh (DAO); Fairmount, 1879 [without collector] (DAO). NORFOLK: Turkey Point, May 20, 1936, *R. J. Stallwood* (OAC); Fisher's Glen, June 2, 1935, *W. M. Bowden* (McM). WATERLOO: gravelly roadside, near Ayr, Sept. 6, 1941, *F. H. Montgomery 877* (DAO, McM, OAC); dry river flats below Galt, May 25, 1941, *F. H. Montgomery 876* (DAO, McM, OAC); on the west river road, Galt, June 4, 1893, *W. Herriot* (OAC). WELLAND: Niagara, May 31, 1901, [probably J. Macoun] (CAN); lot 8, conc. II, Bertie Tp., Sept. 20, 1950, *Bert*

Miller 158 (McM): in wooded areas near the [Niagara] Glen—Hamilton (26), Crystal Beach—Zenkert (14). WENTWORTH: thickets along fences south of Asylum, Hamilton, May 21, 1889, *T. J. W. Burgess* (McM). YORK: thickets, Lambton, May 3, 1905, *A. Cosens* (TRT); Humber [Valley], Toronto May 29, 1933, *H. H. Brown* (TRT).

20. *Prunus serotina* Ehrh.- WILD BLACK CHERRY, RUM CHERRY.

For general distribution this species may be compared with the Eastern Cottonwood (see Little (31), Figs. 88 and 77, respectively), being very common to most of eastern North America from the forty-ninth parallel southward. Pioneers' let-

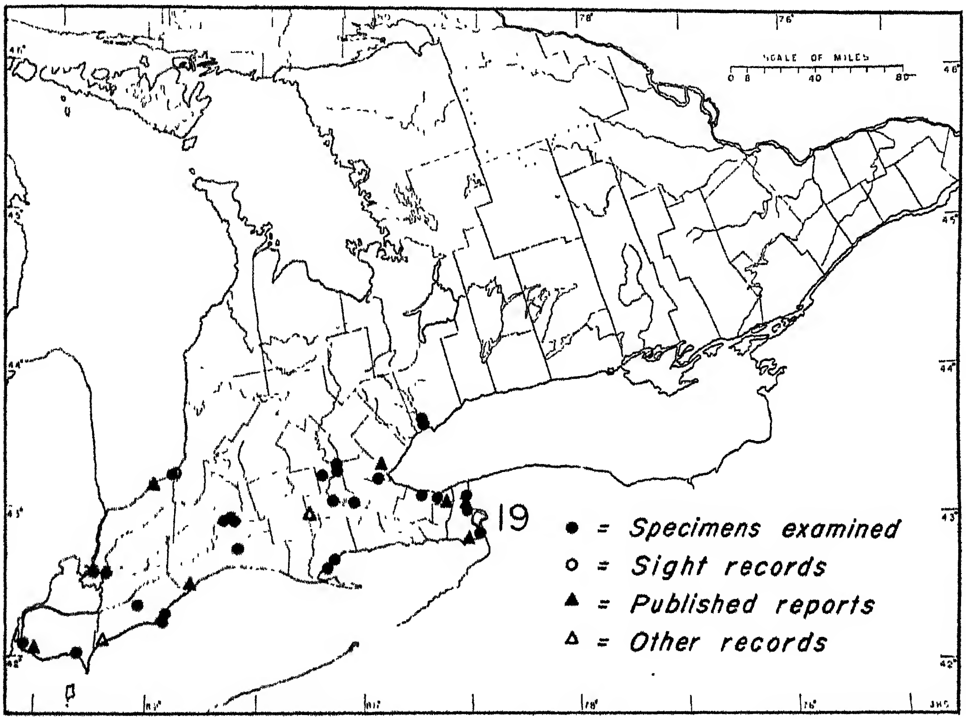

FIG. 19. Distribution of Wild Crab (*Pyrus coronaria*).

ters, the records of early travellers, the notes of the first surveyors, all establish the fact that the Black Cherry was one of the most abundant trees of the primeval forest. Because of the beauty, strength and durability of its wood as a material for the best types of household furniture, the tree was ruthlessly felled from the beginning of colonization onward.

In the dense original woods it grew to an immense size and attained a great age. On one old stump nearly four feet in diameter one of the authors has counted more than four hundred rings; familiar to both authors are two enormous Black Cherries which, spared by the first surveyors of Goderich Township, Huron County, have continued their lives unmolested on a little-used road allowance. One tree is, by measurement, ninety-two feet high and has a trunk ten feet ten inches in circumference.

As early as 1800 the Moravian missionaries at Fairfield on the lower Thames made furniture of Black Cherry. Of the countless trees still surviving in all southern Ontario, rare indeed are those of more than modest size.

The large number of sight records on the map (Fig. 20) indicates that the true abundance of this forest tree in our province is not at all well shown by the preserved specimens or the published records available to date. The following list of records is merely a selection of those available but includes primarily those which are a contribution by the present authors.

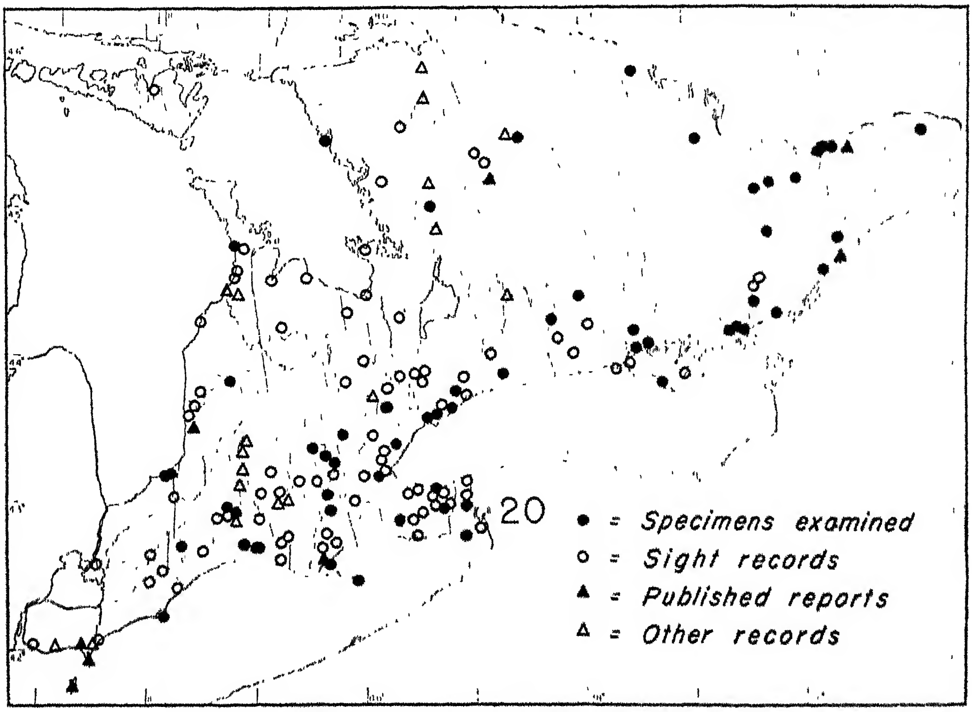

FIG. 20. Distribution of Black Cherry (*Prunus serotina*).

BRANT: roadside, Whiteman Creek, Brantford Tp., July 21, 1949, *W. H. Minshall 4000* (DAO); lot 15, conc. IV, Dumfries S. Tp., June 26, 1950, *J. H. Soper* (s.r.); lot 24, conc. VI, Tuscarora Tp., May 28, 1950, *J. H. Soper* (s.r.). BRUCE: dry sandy ground, Red Bay, Aug. 29, 1926, *W. R. Watson* (TRT); Frenchman Bay, L. Huron, June 17, 1948, *J. H. Soper* (s.r.); Gunn Point, L. Huron, June 18, 1948, *J. H. Soper* (s.r.); Sauble Beach, June 6, 1950, *J. H. Soper* (s.r.); 4 miles northwest of Wiarton, June 9, 1952, *J. H. Soper* (s.r.). CARLETON: Ottawa, June 1, 1892, *Wm. Scott* (TRT); lot 18, conc. XI, Goulbourn Tp., July 31, 1946, *J. H. Soper et al. 3337* (DAO). DUFFERIN: Wheeler Lake, E. Garafraxa Tp., Aug. 6, 1948, *J. H. Soper* (s.r.); Mono Centre, June 5, 1952, *J. H. Soper* (s.r.). DURHAM: woods, Hampton, June 18, 1927, *A. E. Allin* (TRT); lot 27, conc. III, Darlington Tp., June 13, 1950, *J. H. Soper* (s.r.). ELGIN: White's Pond, Springwater, May 25, 1941, *D. A. Young* (TRT); lot 17, conc. I, Dunwich Tp., July 22, 1948, *J. H. Soper* (s.r.); lot 13, conc. III, Bayham Tp., May 28, 1950, *J. H. Soper* (s.r.); lot 15, conc. IX, Bayham Tp., May 29, 1950, *J. H. Soper* (s.r.). ESSEX: near Malden Centre, July 27, 1948, *J. H. Soper* (s.r.); Point Pelee—Dodge (7); Pelee Island—Core (6); Leamington (Macoun)—Groh & Senn (25); lot 19, conc. III, Mersea

Tp., June 19, 1953, *J. K. Shields* (s.r.); near Harrow, June 12, 1953, *J. K. Shields* (s.r.). FRONTENAC: Battersea, May 28, 1904, *J. Fowler* (QU); Collins Bay, June 11, 1902, *J. Fowler* (QU); along stream connecting Hart Lake and Lake Opinicon, June 19, 1952, *J. H. Soper* (s.r.). GRENVILLE: Spencerville, July 15, 1939, *W. H. Minshall 873* (DAO); near Prescott—Billings (1). GREY: Harrison Park, Owen Sound, June 6, 1951, *J. H. Soper* (s.r.); near Meaford, June 7, 1950, *J. H. Soper* (s.r.); Rocky Saugeen, June 10, 1952, *J. H. Soper* (s.r.). HALDIMAND: one mile southwest of Darling Road, June 1, 1951, *Bert Miller 200* (McM); lot 21, conc. I, Moulton Tp., and lot 3, conc. II, Sherbrooke Tp., June 17,1950, *J. H. Soper* (s.r.). HALIBURTON: Oxtongue Lake, July 8, 1951, *J. H. Soper* (s.r.); vicinity of Otter Lake (Hardwood L.)—Wright & Simpson (43). HALTON: Trafalgar, May, 1, 1938, *H. H. Brown* (TRT); lot 5, conc. II, Nelson Tp., May 22, 1951, *J. H. Soper* (s.r.); near Kelso, May 25, 1950, *J. H. Soper* (s.r.); Mount Nemo, May 21, 1952, *J. H. Soper* (s.r.). HASTINGS: vicinity of Belleville, June 10, 1878, *J. Macoun* (CAN); near Chatterton, July 13, 1939, *W. H. Minshall 602* (DAO). HURON: Wingham, June 3, 1891, *J. A. Morton* (CAN); lot 18, conc. II, W. Wawanosh Tp., June 20, 1948, *J. H. Soper* (s.r.); lot 6, conc. X, Goderich Tp., Aug. 1, 1950, *J. H. Soper* (s.r.); two enormous trees along sideroad about 6 miles south of Goderich, Aug. 27, 1953, *W. S. Fox & J. H. Soper* (s.r.); Bayfield River, L. Huron (Gibson)—Macoun & Gibson (35). KENT: mixed hardwood forest, Rondeau Provincial Park, Aug. 15, 1940, *J. H. Soper 2368* (DAO, McM); near Clearville, July 27–28, 1948, *J. H. Soper* (s.r.); near Wheatley, Aug. 3, 1950, *J. H. Soper* (s.r.); lots 7 & 10, River Range, Howard Tp., June 24–25, 1950, *J. H. Soper* (s.r.); lot 6, conc. VIII, Zone Tp., June 25, 1950, *J. H. Soper* (s.r.). LAMBTON: sandy soil along roadside south of Grand Bend, July 18, 1940, *J. H. Soper et al. 2206* (DAO, McM); north end of Walpole Is., L. St. Clair, Aug. 4, 1950, *J. H. Soper* (s.r.); Arkona Rock Glen, Aug. 6, 1950, *J. H. Soper* (s.r.); lot 24, conc. XIV, Dawn Tp., Aug. 12, 1941, *J. H. Soper* (s.r.). LANARK: Almonte, July 28, 1939, *W. H. Minshall 1747* (DAO); on Tay Canal east of Perth, Sept. 10, 1947, *Dore & Gillett 47-1025* (DAO); Clayton, July 21, 1943, *Dore & Groh* (DAO). LEEDS: Gananoque, Aug. 18, 1887, *J. Fowler* (QU); Elizabethtown, May, 1887, *T. G. Allen* (QU); vicinity of Lake Opinicon, June 17, 1952, *J. H. Soper* (s.r.). LINCOLN: wooded slope, Jordan Harbour, June 17, 1940, *H. M. Harrison* (OAC); lot 2, conc. II, N. Grimsby Tp., May 22, 1951, *J. H. Soper* (s.r.); lot 1, conc. VI, Clinton Tp. and lot 8, conc. II, Louth Tp., May 29, 1951, *J. H. Soper* (s.r.); near Niagara-on-the-Lake, May 30, 1951, *J. H. Soper* (s.r.); lot 19, conc. VII, S. Grimsby Tp., June 19, 1950, *J. H. Soper* (s.r.). MANITOULIN: woods along escarpment on the west side of Manitou Lake, July 7, 1953, *J. H. Soper* (s.r.). MIDDLESEX: London, Aug. 5, 1937, *W. S. Fox* (WO); Glencoe, June 13, 1893, *N. D. Keith* (McG); lot 25, conc. I, London Tp. and lot 10, conc. I, Lobo Tp., June 24, 1950, *J. H. Soper* (s.r.); near Putnam, May 29, 1950, *J. H. Soper* (s.r.); Pond Mills and near Mt. Brydges, July 19, 1950, *J. K. Shields* (s.r.). MUSKOKA: Milford Bay, June 24, 1942, *W. H. Minshall 3094* (DAO); Bella Lake, near Huntsville, July 5, 1948, *J. H. Soper* (s.r.); Skeleton Lake, July, 1953, *J. K. Shields* (s.r.); island in Prospect Lake, near Gravenhurst, *J. K. Shields* (s.r.). NIPISSING: Cache Lake, Algonquin Park, June 7, 1900, *J. Macoun* (CAN); Canoe Lake (*Mowat*), June 27, 1950 fide R. D Ussher. NORFOLK: Turkey Point, June 3 & July 5, 1938, *J. H. Soper 517 & 554* (McM); sandy ridge, Long Point, July 28, 1951, *Falls & Klawe 659* (TRT); lot 3, conc. I, Townsend Tp., May 20, 1949, *M. Landon* (ML); lot 9, conc. XI-XII, Windham Tp., May 28, 1950, *J. H. Soper* (s.r.); lots 2–3, conc. III, Woodhouse Tp., Aug. 27, 1952, *J. H. Soper* (s.r.). NORTHUMBERLAND: lot 14, conc. X, Percy Tp., June 12, 1948, *J. H. Soper* (s.r.); lot 22, conc. VII, Haldimand Tp., Aug. 13, 1948, *J. H. Soper* (s.r.). ONTARIO: Frenchman's Bay, Oct. 1, 1939, *R. M. Belyea* (s.r. JHS). OXFORD: lot 35, conc. IX, E. Zorra Tp., July 29, 1948, *J. H. Soper* (s.r.); lot 5, conc. VII, W. Zorra Tp., June 23, 1950, *J. H. Soper* (s.r.); lot 7, conc. XII, Dereham Tp., June 26, 1950, *J. H. Soper* (s.r.); lot 2, conc. VI, Blandford Tp., and lot 2, conc. V, Blenheim Tp., June 23, 1950, *J. H. Soper* (s.r.); lot 12, conc. XII, E. Nissouri Tp., May 30, 1950, *J. H. Soper* (s.r.); lot 21, conc. V, E. Oxford Tp. and lot 15, conc. I, W. Oxford Tp., July 28, 1950, *J. K. Shields* (s.r.). PARRY SOUND: among cedars, Chinook

Is., opposite Shawanaga Tp., July 22, 1942, *E. D. McDonald Jr. 180* (CAN, TRT); lot 14, conc. V, Croft Tp., June 26 July 13, 1951, *J. H. Soper* (s.r.); Blackstone Lake, July 24, 1952, *J. H. Soper* (s.r.); Sollman Lake, Beatty Lake, and Ruth Lake, Aug. 1953, *J. K. Shields* (s.r.). PEEL: Snelgrove, June 15, 1907, *J. White* (TRT); lot 15, conc. III, Albion Tp., Aug. 4, 1948, *J. H. Soper* (s.r.); lots 2-4, conc. III W., Caledon Tp., *A. F. Coventry* (s.r.). PERTH: lot 6, conc. IV, Logan Tp. and lots 10-11, conc. IV, Fullerton Tp., July 25, 1950, *J. K. Shields* (s.r.); near St. Marys, July 26, 1950, *J. K. Shields* (s.r.). PETERBOROUGH: 2 miles west of Centre Dummer, June 11, 1948, *Soper & Dale 3384* (TRT); Peterborough, Aug. 22, 1949, *E. G. Anderson 860* (DAO); lot 12, conc. XI, Otanabee Tp., June 12, 1948, *J. H. Soper* (s.r.). PRESCOTT: 2 miles west of Vankleek Hill, July 26, 1939, *W. A. Minshall 1418* (DAO). PRINCE EDWARD: north side of Athol Bay, Sept. 5, 1949, *C. & M. Heimburger* (TRT); near Carrying Place, Oct. 8, 1949, *M. Heimburger* (s.r. JHS); mouth of Black River, Aug. 5, 1951, *J. H. Soper* (s.r.). RENFREW: along the Petawawa River, Chalk River, July 24, 1948, *A. J. Breitung 6950* (CAN, DAO, TRT); 4 miles northeast of Douglas, July 28, 1939, *W. H. Minshall 1750* (DAO). RUSSELL: Navan, Sept. 4, 1911, *J. Macoun* -Groh & Senn (25). SIMCOE: near Singhampton and near mouth of Nottawasaga River, June 29, 1950, *J. H. Soper* (s.r.); near Holly, June 30, 1950, *J. H. Soper* (s.r.); wet woods, Thunder Beach, Aug. 9, 1952, *J. H. Soper* (s.r.). VICTORIA: Sturgeon Point, June 6, 1953, report of Peterborough Nature Club in Nature News, June 1953. WATERLOO: at the town limit, Galt, June 13, 1893, *W. Herriot* (OAC); one mile west of Kitchener, June 9, 1940, *F. H. Montgomery 622* (DAO, McM, OAC); Doon, June 6, 1948, *C. R. Tilt* (McM). WELLAND: 2 miles west of Niagara, Aug. 1891, *J. Dearness* (CAN); lot 1, conc. IV, Pelham Tp., May 28, 1948, *Soper & Dale 3758* (TRT); sandy soil, Point Abino, May 30, 1950, *Bert Miller 28* (McM); near Stamford Centre, May 29, 1951, *J. H. Soper* (s.r.); near Thorold, June 18, 1950, *J. H. Soper* (s.r.); near Fort Erie north, May 20, 1950, *J. H. Soper* (s.r.). WELLINGTON: rich woods, Guelph, June 5, 1937, *J. J. Stroud* (TRT). WENTWORTH: Royal Botanic Garden [Hamilton], June 25, 1932, *H. A. Senn* (McM); La Salle Park, E. Flamborough Tp., May 22, 1951, *J. H. Soper* (s.r.); lot 30, conc. I, Ancaster Tp., June 22, 1950, *J. H. Soper* (s.r.). YORK: near Scarborough, June 9, 1899, *E. M. Walker* (TRT); about 5 miles northeast of Agincourt, June 9, 1950, *Soper & Shields 4614* (TRT); lots 13 & 15, conc. I, Whitchurch Tp., Sept. 17, 1948, *J. H. Soper* (s.r.); near Donlands Station, York Tp., May 10, 1951, *J. H. Soper* (s.r.); lot 18, conc. VI, King Tp., June 28, 1950, *J. H. Soper* (s.r.); lot 34, conc. II, Vaughan Tp., Aug. 13, 1950, *M. Heimburger* (s.r. JHS).

EXCLUDED RECORD: A single report for the Thunder Bay District was published by Macoun (12) when he gave the range of *Prunus serotina* as extending ". . . as far west as the Kaministiquia River, Lake Superior". No specimens have been seen from this district although the Choke Cherry (*Prunus virginiana* L.) is known at intervals all along the north shore of Lake Superior. *Prunus serotina* is not reported by Lowe (32) for Manitoba nor by Stevens (42) for North Dakota. In Minnesota it is found, according to Rosendahl and Butters (39), ". . . practically throughout the state except in the region north of Lake Superior . . .". We may conclude that Macoun's report stemmed from a fortuitous introduction or from a definite misidentification.

LEGUMINOSAE Pulse Family

21. *Cercis canadensis* L.—REDBUD, JUDAS-TREE.

In all probability the Redbud's specific name, *canadensis*, was given during the French régime when Canada extended far down the Mississippi valley. Any claim that Canada as we now know it may have had upon this species as a native rests upon a single tree which John Macoun had seen in 1892 in a manifestly wild state on Pelee Island.

Redbud has been planted in many places throughout southern Ontario but

does not appear to be hardy much beyond the area in which Sassafras and Flowering Dogwood flourish.

The location of the single indigenous tree (now extinct) is shown in map 21, Fig. 21, that is based on the following record:

ESSEX: south point of Pelee Island, Lake Erie, July 28, 1892, [*John*] *Macoun* (CAN). Reported also by J. M. Macoun (34) for "Pelee Island, Lake Erie. (John Macoun.) One tree of this species was pointed out to Prof. Macoun in 1892. An old resident remembered having seen this tree in his boyhood, but knew of no other on the island. It grows close beside the lake, and is doubtless indigenous."

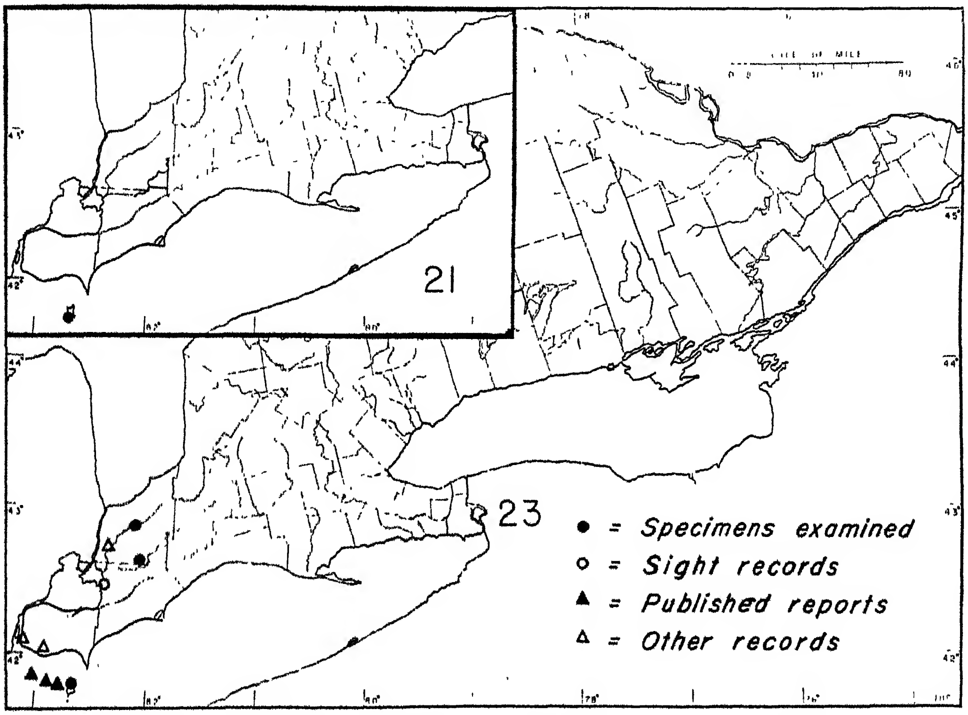

FIG. 21. Map 21: Distribution of Redbud (*Cercis canadensis*).
Map 23: Distribution of Kentucky Coffee-Tree (*Gymnocladus dioica*).

22. *Gleditsia triacanthos* L.—HONEY-LOCUST.

Macoun's observation (12, part I, p. 124) on the Honey-Locust is of vital importance: "This species is common in cultivation throughout Ontario, and is quite hardy. In the summer of 1882 numerous trees of it were found growing on the sand dunes of Pelee Point. The seed had probably drifted across the lake from Ohio, as sand is not the true habitat of this tree." There is good reason to believe that the only Honey-Locust trees *truly* native to Canada are those found on and close to Point Pelee and that Macoun rightly divined the way in which Nature brought the species here. All other specimens in the Province would seem to be plantings by man or are seedlings from that stock. In the mid-eighties, as the

senior author of this paper himself saw, United States nurserymen were still planting Honey-Locust hedges in many parts of rural Ontario. The species has a range in the United States that extends from central New York to northern Florida, along the Gulf to eastern Texas, and thence north to eastern South Dakota. Extensive plantings everywhere have obscured the exact limits of its natural distribution.

Four records (in Essex County), assumed to be of native stands, have been plotted on the map (Fig. 22), as well as other records that represent only a sample

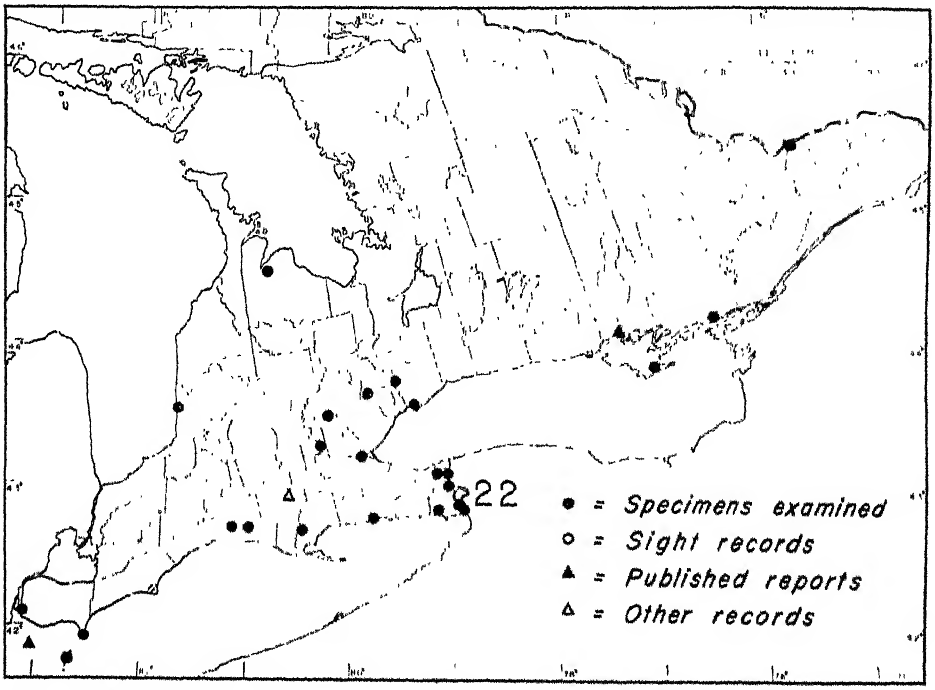

FIG. 22. Distribution of Honey-Locust (*Gleditsia triacanthos*), including records of both native and planted specimens.

of the more numerous specimens assumed to have been planted. The data for the map are as follows:

CARLETON: Ottawa [with note: "introduced here"], June 15, 1891, *Wm. Scott* (OAC). ELGIN: Aylmer,—, *R. T. Anderson* (TRT); conc. VIII, Yarmouth Tp., Sept. 1, 1941, *D. A. Young* (TRT). ESSEX: Pelee Island, 1938, *W. Botham* (DAO); sandy ridges along Lake Erie shore, west side of Point Pelee, Aug. 29, 1940, *J. H. Soper 2460* (DAO, McM); Amherstburg, June 7, 1901, *J. Macoun* (CAN); Middle Sister Island—Core (6). FRONTENAC: Kingston, Oct. 16, 1901, *J. Fowler* (QU). GREY: Sydenham Tp., Oct. 1, 1935, *per. A. S. Millard* (DAO). HALDIMAND: 2 miles southeast of Rainham, Oct. 5, 1951, *Bert Miller 698* (McM). HASTINGS: Belleville (*Macoun*)—Macoun & Gibson (35). HURON: along bank of Bayfield River, Bayfield, Aug. 1, 1951, *J. H. Soper 5374* (TRT). LINCOLN: 2 miles south of Homer, June 25, 1952, *Bert Miller 364* (McM); Queenston, Sept. 7, 1898, *Wm. Scott* (TRT). NORFOLK: Woodhouse Tp., July 30, 1948, *M. Landon* (McM). OXFORD:

about half a mile north of Norwich, *Wm. Miles* (corr. WSF). PEEL: Snelgrove, June 17 & Aug. 20, 1911, *J. White* (TRT). PRINCE EDWARD: roadside near a barn [where probably planted], between Milford and South Bay, Oct. 22, 1950, *M. L. Heimburger* (TRT). WATERLOO: Galt, June 24, 1893, *W. Herriot* (OAC). WELLAND: Niagara Falls, June 6, 1896, *Wm. Scott* (CAN, DAO); Miller's Creek, Niagara Boulevard, June 21, 1950, *Bert Miller 76* (McM); Fort Erie, Oct. 14, 1948, *Bert Miller 892* (McM); lot 14, conc. II, Humberstone Tp., June 29, 1950, *Bert Miller 89* (McM, TRT). WELLINGTON: Guelph, June 24, 1938, *J. J. Stroud* (TRT). WENTWORTH: Hamilton district—Dickson & Alexander (19). YORK: Pine Grove, July 10, 1932, *H H. Brown* (TRT); Toronto, Oct. 1939, *L. T. Owens* (TRT).

23. *Gymnocladus dioica* (L.) K. Koch—KENTUCKY COFFEE-TREE.

An early traveller in the region of the lower Great Lakes noticed this tree. About 1710 Raudot wrote in his MEMOIRS (9, p. 385): "there are also trees that have large pods in which are found black stones and a kind of green ointment whose usage the savages do not know".

The native range of this tree in North America corresponds closely to the northern half of the Honey-Locust's range. In Ontario, however, it extends northward from latitude 42° almost to 43°, being found in Kent and Lambton Counties in addition to Essex. With the exception of a single dense stand (along with Papaws) near Mitchell Bay on Lake St. Clair, specimens of this rare Ontario tree are solitary and widely scattered.

It is frequently planted for ornamental purposes in various parts of the Province and has proved to be hardy far north of its natural habitat. The tree's English name is derived from the somewhat limited use of its seeds by the pioneers as a substitute for coffee beans.

The distribution of the known native stands of Kentucky Coffee-Tree is given on map 23, Fig. 21, and the records are as follows:

ESSEX: north end of Pelee Island, Lake Erie, July 28, 1892, *J. Macoun* (CAN); Hen, East Sister, and Middle Sister Islands, Lake Erie—Core (6); near Harrow, 1949, *Bert Miller* (s.r.); near Amherstburg, Sept. 28, 1949, *Bert Miller* (corr. WSF). KENT: Mitchell Bay, Lake St. Clair, 1942, *W. S. Fox* (s.r.). LAMBTON: about three miles southwest of Florence, Dawn Tp., June 25, 1950, *Soper & Shields 4811* (TRT); along Bear Creek, near Petrolia, Aug. 11, 1941, *J. H. Soper 2831* (DAO, TRT); in the valley of a tributary of the Syndenham River at Wilkesport, *Harold Zavitz* (corr. WSF).

CELASTRACEAE—Staff-Tree Family

24. *Euonymus atropurpurea* Jacq.—BURNING BUSH, WAHOO, SPINDLE-TREE.

The extent of territory to which our beautiful native Spindle-Tree belongs may be grasped by projecting the range of the Kentucky Coffee-Tree west to Nebraska, south to Florida and southern Arkansas, and, in Ontario, north to a line close to parallel 43° 30′, drawn from Exeter (Huron County) to Toronto. This near relative of our native Climbing Bittersweet is rarely found growing wild in Ontario, though frequently seen planted in private gardens and in parks where, in its gorgeous fall display of colour, which entitles it to the name of Burning Bush, it is often mistaken for the European Spindle-Tree.

The locations of stations for this shrub are shown on map 24, Fig. 23, and the records follow:

ESSEX: woodlot 5 miles northeast of Essex, June 13, 1953, *J. K. Shields 1282* (TRT); dry thickets, White Island, Amherstburg, June 11, 1882, *J. Macoun* (CAN); Windsor, July 28, 1901, *J. Macoun* (CAN, GH); Malden (*Maclagan*) Macoun (12); Point Pelee, Pelee Island and Hen Island—Dodge (7); Middle Island and Middle Sister Island Core (6). HURON: near Exeter, *W. T. Brown* (corr. WSF). LAMBTON: Forest, June, 1895, *R. Campbell*, (McG). LINCOLN: low woods between St. Catharines and St. Davids, June 22 & Sept. 24, 1897, *W. C. McCalla* (CAN, TRT); along edge of river bank, Twelve-Mile Creek near DeCew Falls, July 5, 1950, *Soper & Shields 4898* (TRT). MIDDLESEX: W. [Westminster] Pond, May 30, 1878 [collector not stated but probably G. W. Clinton or W. E. Saunders] (DAO); west of London, July 20, 1889, *J. Dearness* (CAN). NORFOLK: Turkey Point, Sept. 25, 1948, *M.*

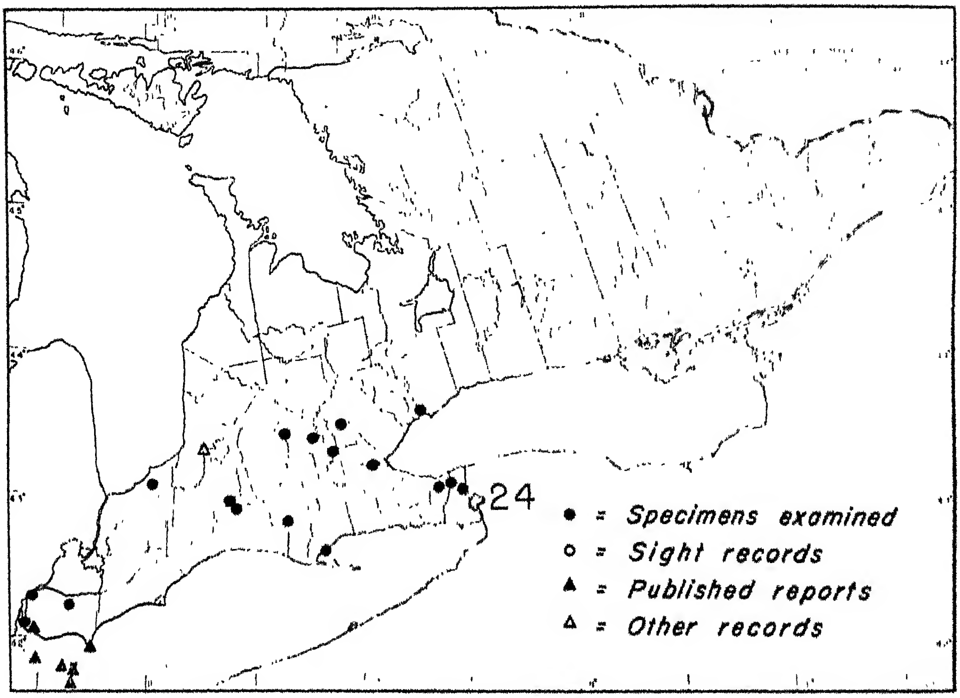

FIG. 23. Distribution of Burning Bush (*Euonymus atropurpurea*).

Landon (ML). OXFORD: Tillsonburg, July 1, 1898, *Alex. H. D. Ross* (QU). WATERLOO: wooded banks, old rifle range, Galt, Aug. 1, 1902, *R. S. Hamilton* (OAC); hillside in dry woods, Kitchener, Sept. 23, 1939 & July 7, 1940, *F. H. Montgomery 647* (DAO, McM, OAC): Wellesley, Oct. 1, 1911, *R. B. Morton* (FFT). WELLAND: Foster's Flats, Niagara, Aug. 26, 1905, *Wm. Scott* (TRT). WELLINGTON: rich woods, Guelph, June 11, 1938, *J. J. Stroud* (TRT). WENTWORTH: thicket on the Dundas Mountain, June 25, 1894, *W. Herriot* (OAC). YORK: in the Humber valley near Toronto, June 16, 1896, Wm. Scott (CAN).

NYSSACEAE—Sour Gum Family

25. *Nyssa sylvatica* Marsh. (incl. var. *caroliniana* (Poir.) Fern.)—SOUR GUM, BLACK GUM, TUPELO, PEPPERIDGE.

According to Fernald & Kinsey (22) the name Sour Gum was derived from the pleasantly acid fruits produced by this tree. The other names are either obscure in

origin or meaningless except as locally accepted labels; the tree is wholly without gum. It is indigenous to the eastern third of the United States, thinly scattered over this area, generally in poorly drained localities.

In Ontario it is found thinly distributed in the narrow belt of territory that parallels the north shore of Lake Erie from the Niagara to the Detroit. In most places specimens are solitary, but along the south bank of the Thames River near Thamesville (Kent Co.) may be seen a fairly large number of the species near stations of other "Carolinians"—Sweet Chestnut, Papaw, Sassafras and Flowering Dogwood. Its horizontal branching, in which it resembles the Beech, and its glossy

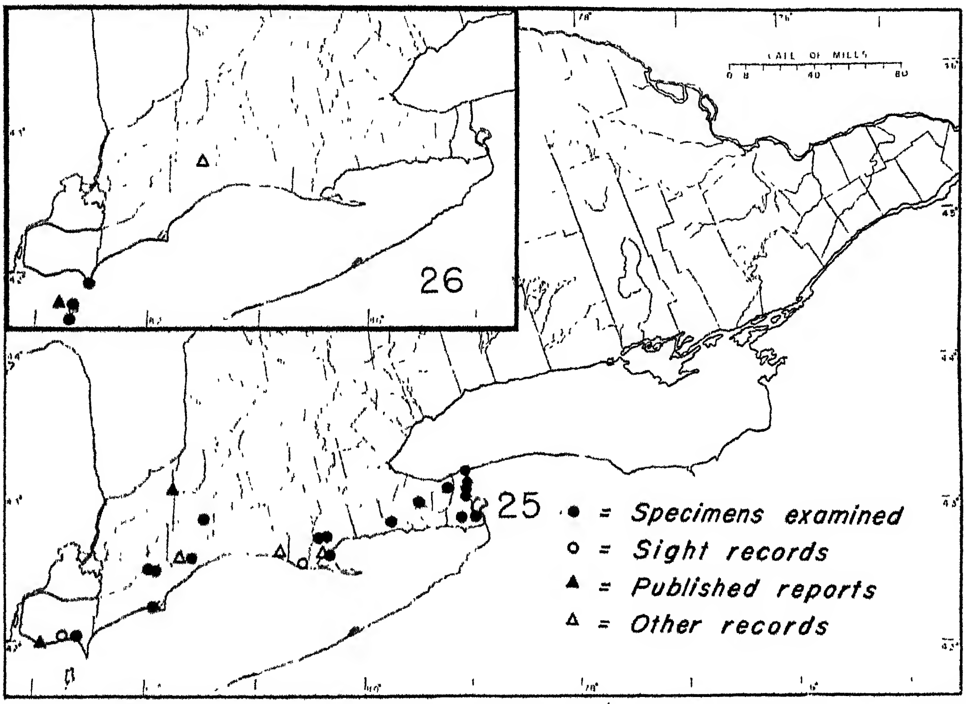

FIG. 24. Map 25: Distribution of Pepperidge (*Nyssa sylvatica*).
Map 26: Distribution of Blue Ash (*Fraxinus quadrangulata*).

green-wine mottled autumn foliage, make it worthy of more attention for ornamental planting than it has received in the past.

Map 25, Fig. 24, gives the location of known stands and the records are as follows:

ELGIN: swampy woods, Bismark, west of St. Thomas, June 15 & 30, 1882, *J. Macoun* (CAN): north side of Otter River near Vienna, *Mrs. John A. Rose* (corr. WSF); south of Wardsville, *H. L. Lancaster* (corr. WSF). ESSEX: low woods, Leamington, July 1, 1882, *T. J. W. Burgess* (CAN, TRT); near Colchester—Dodge (7); near Kingsville, *W. S. Fox* (s.r.). HALDIMAND: 3 miles east of Upper, July 6, 1951, *Bert Miller 408* (McM). KENT: field by side of road, about 2 miles southwest of Thamesville, June 24, 1950, *Soper & Shields 4794* (TRT); along roadside between Highgate and Thamesville, Aug. 16, 1940, *J. H. Soper et al. 2413* (DAO, GH, McM); Erieau, Sept., 1943 [without collector] (OAC). LAMBTON: near the high

banks of the Aux Sables River below Rock Glen—Dodge (20). LINCOLN: edge of swale in dense woods, about 2 miles northeast of Bismark, Aug. 13, 1952, *J. H. Soper 5833* (TRT); damp ground near St. Catharines, June 10 & Sept. 21, 1897, *W. C. McCalla* (CAN); swamps, Queenston, June 13, 1892, *J. Macoun* (CAN); Niagara [probably Niagara-on-the-Lake as reported by J. M. Macoun (34) and seen by the junior author on several occasions], Oct. 5, 1908, *Wm. Scott* (TRT). MIDDLESEX: swamps, Caradoc Tp., 1890, *J. Dearness* (WO) - probably collected near Mt. Brydges, whence it was reported to W. S. Fox by Dr. Dearness. NORFOLK: Turkey Point, June 18, 1932, *H. H. Brown* (TRT); lot 18, conc. VI, Charlotteville Tp., July 22, 1948, *M. Landon* (McM); 2 miles west of Walsh, Aug. 1, 1942, *R. F. Cain* (TRT); St. Williams, *J. Dearness* (s.r.); lots 1–2, conc. III, Walsingham Tp., Aug. 20, 1952, *J. H. Soper* (s.r.). WELLAND: Niagara Glen, 1950, *H. Boothman* (NPC); dry sandy woods southwest of Queenston, July 25, 1941, *J. H. Soper 2767* (DAO, TRT); lot 13, conc. VI, Bertie Tp., May 27, 1950, *Bert Miller 15* (McM, TRT); lot 3, conc. IV, Humberstone Tp., Sept. 18, 1950, *Bert Miller 141* (McM).

OLEACEAE—Olive Family

26. *Fraxinus quadrangulata* Michx.—BLUE ASH.

The limited range of this tree in North America might be compared with that of the Kingnut Hickory (see Little (31), Figs. 34 and 46, respectively). The species is now very rare in southern Ontario, but was probably quite common in the original forest along the north shore of Lake Erie. Both Indians and white colonists have brought it close to extinction: the former found in its sap the source of their best blue dye; the latter preferred its heavy snow-white sapwood to all other woods used for tool handles. For ornamental planting it is perhaps the most attractive of our native Ashes and is easily grown.

Its habitat in southern Ontario is usually dry sandy or rocky ground within the area underlain by Devonian strata. The records are plotted on map 26, Fig. 24, and are listed below:

ESSEX: on rocky soil, north end of Pelee Island, July 28, 1892, *J. Macoun* (CAN); on limestone, Middle Island, May 9–10, 1939, *H. A. Senn 1117* (DAO); behind first sandy ridge parallel to west shore, Point Pelee, Aug. 29, 1940, *J. H. Soper 2463* (DAO, McM); Hen Island—Core (6). MIDDLESEX: near Melbourne, *Edwin Graff* (corr. WSF).

RUBIACEAE—Madder Family

27. *Cephalanthus occidentalis* L.—BUTTON-BUSH.

The Button-Bush is one of the most widely distributed of all the trees and shrubs known to the region included in this survey. It is found from the Maritime Provinces south to Florida, west to Texas, and from southwestern Quebec through southern Ontario to Minnesota. It also occurs in California and the West Indies. The northernmost records for Ontario are from the Magnetewan River on the west to the Barron River, flowing into the Ottawa, on the east.

Button-Bush may justly be considered a southern species in our region. It seldom attains the dimensions of a tree, more frequently growing as a shrub with several stems from the ground or branching near the ground. Yet one of the authors has observed a plant with a trunk eleven inches in diameter growing beside Highway No. 21 between Goderich and Kincardine. A dense stand of

arborescent specimens used to exist in the extensive fertile alluvial plains of the lower Aux Sables River where Middlesex and Huron Counties adjoin one another.

The usual habitat for Button-Bush is wet ground along streams, at the edge of ponds, bays, or marshes, or in damp depressions of fields and roadside ditches where the roots are in water at least part of the year. The records are plotted on map 27, Fig. 25, and the data listed below.

BRANT: swamps along streams, Burford, Aug. 20, 1927, *R. F. Cain* (TRT), lot 6, conc. IV, Tuscarora Tp., July 27, 1941, *J. H. Soper* (s.r.). BRUCE: Oliphant, Aug. 4, 1932, *F. Marie-*

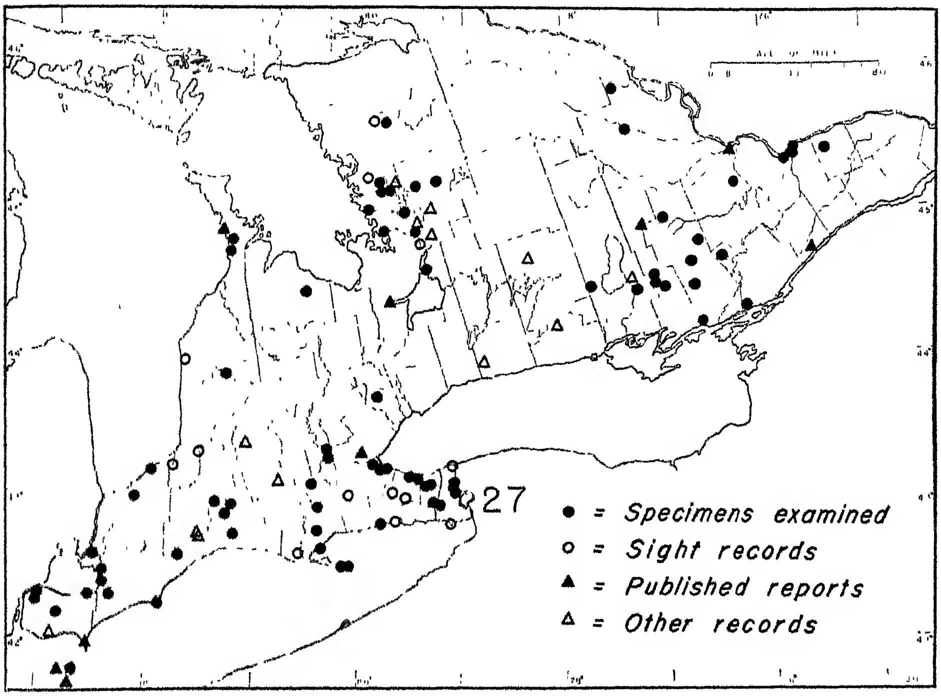

FIG. 25. Distribution of Button-Bush (*Cephalanthus occidentalis*).

Victorin et al. 46400 (MT, TRT); Sky Lake, Aug. 19, 1926, *W. R. Watson* (TRT); along the Pike River—Klugh (29). CARLETON: swamp, Billings Bridge, Ottawa, Aug. 17, 1878, *J. Fletcher* (DAO); Britannia Bay, Ottawa River, July 29, 1942, *Senn & Zinck 993* (DAO); between Galetta and Marshall's Bay—Ami (15). DURHAM: Baker's Bog, near Hampton, fide A. E. Allin (corr. JHS). ELGIN: St. Thomas, Aug. 5, 1941, *D. A. Young* (TRT); southeast of Wardsville, Aug. 11, 1953, *W. W. Judd* (TRT); along Thames River in Dunwich Tp., Dougald Murray (corr. JHS). ESSEX: damp thicket, Sandwich, July 22, 1901, *J. Macoun* (CAN, GH); sandy ridges, Lake St. Clair shore in Tilbury Tp., Aug. 27, 1938, *L. O. Gaiser* (McM); sandy loam, southeast of Windsor, July 13, 1951, *Mulligan & Lindsay 837* (DAO); Pelee Island, July 27, 1891,— (OAC); Essex, July 29, 1913, *M. O. Malte* (CAN); Middle Island and Little Chicken Island—Core (6); Point Pelee—Dodge (7); Cedar Creek, June 10, 1953, *J. K. Shields* (s.r.). FRONTENAC: Parham, Aug. 18, 1947, *M. F. Jackson* (TRT), along boggy stream bank, Oso Tp., Sept. 11, 1947, *Dore & Gillett 47–1063* (DAO); near

Collins Bay peat bog, July 17, 1947, *J. M. Gillett 1411* (DAO); Plevna, Aug. 13, 1902, *J. Fowler* (QU); Verona, Sept. 12, 1901, *J. Voaden* (QU): between Upper Rock Lake and Stonehouse Lake, July 22, 1952, *J. K. Shields 696* (TRT); Upper Rock Lake, 7 miles east of Perth Road, July 23, 1952, *J. M. Gillett 6566* (DAO); vicinity of Lake Opinicon, Aug. 1, 1952, *J. K. Shields 796* (TRT). GRENVILLE: marsh south of Prescott Junction Billings (1). GREY: low ground along stream, lots 17 19, conc. III, Euphrasia Tp., Aug. 11, 1952, *J. H. Soper 5781* (TRT). HALDIMAND: Evan's Point, L. Erie, July 25, 1951, *Bert Miller 463* (McM); lot 12, conc. V, Dunn Tp., Aug. 2, 1941, *J. H. Soper* (s.r.). HASTINGS: near Stoco, Aug. 3, 1948, *A. J. C. Barry* (TRT); sandy shore, Crow Lake, July 24, 1952, *J. M. Gillett 6628* (DAO); near Actinolite, Sept. 17, 1952, *J. K. Shields* (s.r.). HURON: swamps, Wingham, July 18, 1890, *J. A. Morton* (CAN); lot 21, conc. VI, Stephen Tp., Aug. 2, 1950, *J. H. Soper* (s.r.); a large specimen (trunk 11 inches in diameter) along Highway No. 21 between Goderich and Kincardine, *W. S. Fox* (s.r.); along Aux Sables River in Stephen Tp., *W. S. Fox* (s.r.). KENT: along Jeannette Creek south of Prairie Siding, Aug. 3, 1950, *Soper & Shields 5063* (TRT); near Mitchell Bay, Aug. 19, 1950, *J. K. Shields 379* (TRT); along beach, Rondeau Provincial Park, July 23, 1948, *Soper & Dale 4037* (TRT); St. Luke's Bay, Aug. 27, 1938, *L. O. Gaiser* (DAO). LAMBTON: Kettle Point, Lake Huron, Aug. 5, 1947, *F. S. Cook* (TRT); Walpole Is., Aug. 19, 1950, *J. F. Calvert* (JFC); about 4 miles southwest of Uttoxeter, Sept. 29, 1952, *M. Heimburger* (TRT). LANARK: Ramsay, Aug. 1862, *J. K. McMorine* (QU). LEEDS: edge of swamp, L. Opinicon, July 2, 1952, *J. K. Shields 601* (TRT); pond margin, north of Westport, July 24, 1947, *Dore & Cody 47 360* (DAO); Gananoque, Aug. 20, 1887, *J. Fowler* (QU). LENNOX & ADDINGTON: 5 miles north of Erinsville, July 22, 1943, *H. Groh* (DAO); Bass Creek, 8 miles south of Kaladar, July 27, 1947, *J. M. Gillett 1440* (DAO); edge of Salmon R., Tamworth, Aug. 14, 1951, *Mulligan & Dore 890* (DAO); Mazinaw Lake [exact locality not stated and possibly also in Frontenac Co.], July 1869--Harrington (27). LINCOLN: dry stream bed, Rockway, Aug. 13, 1952, *J. H. Soper 5810* (TRT); lowland, 3 miles southwest of St. Catharines, July 9, 1952, *Bert Miller 457* (McM); creekside, Vineland, June 22, 1940, *H. M. Harrison* (OAC); Beamsville, Oct. 1, 1933, *H. H. Brown* (TRT); lot 11, conc. IV, Caistor Tp. and near Bismarck in Gainsborough Tp., Aug. 13, 1952, J. H. Soper (s.r.); near Niagara-on-the-Lake, May 30, 1951, *J. H. Soper* (s.r.). MIDDLESEX: swampy thicket, Westminster Ponds, London, Aug. 10, 1885, *T. J. W. Burgess* (TRT); Lambeth, July 1935, *W. G. Colgrove* (WO); Melrose, Sept. 6, 1937, *W. S. Fox* (WO); lots 7, 8 & 10, Range V South, lots 7 & 12, Range IV South, lot 14, Range III South and lot 13 Gore, Ekfrid Tp., *Dougald Murray* (corr. JHS); along Aux Sables River, McGillivray Tp., W S. Fox (s.r.). MUSKOKA: low ground, Gloucester Pool near Port Severn, Sept. 15, 1953, *H. M. Dale* (TRT); marshy edge of bay, Hardy Lake, July 24, 1952, *Soper & Clayson 5646* (TRT); Lake Joseph, Aug. 5, 1901, *E. Robinson* (OAC); Port Sydney, Aug. 15, 1907, *T. J. Ivey* (TRT); Go Home, Georgian Bay, Aug. 18, 1904, *A. G. Huntsman* (CAN); Bass Lake, July 24, 1952, *J. H. Soper* (s.r.); Muldrew Lake, Aug. 12, 1951, fide *J. M. Speirs*; Bracebridge, fide *A. F. Coventry*; Kahshe Lake, Aug. 1936, *Ferne Jones* (corr. JHS). NORFOLK: marsh on Long Point, Aug. 22, 1938, *Senn & Soper 467* (DAO); wet ditches along road near Turkey Point, July 28, 1938, *J. H. Soper 381* (McM); lot 6, conc. III, Windham Tp., July 25, 1948, *M. Landon* (McM); lots 4-5, conc. III-IV, Walsingham Tp., Aug. 20, 1952, *J. H. Soper* (s.r.). NORTHUMBERLAND: Rice Lake, near Roseneath, *Marshall Field* (corr. JHS). ONTARIO: swamp, Atherley, Aug. 18, 1893, *M. Wilkes* (TRT). OXFORD: along the Thames River, near Woodstock, 1947, *Ferne Jones* (corr. JHS). PARRY SOUND: north end of Beaver Lake, Croft Tp., July 5, 1951, *J. H. Soper 5260* (TRT); Portage Lake north of Gordon Bay, Aug. 15, 1943, *D. M. Britton 55* (TRT); Blackstone Lake and Whitestone Lake, July 24, 1952, *J. H. Soper* (s.r.); Barnesdale, fide *A. F. Coventry*. PEEL: Snelgrove, July 25, 1908, *J. White* (TRT). PERTH: along the Black Creek, 3 miles west of Sebringville, *N.E. Dahms* (corr. JHS). PETERBOROUGH: on the Mississagua River about a mile below Mississagua Lake, Harvey Tp., Aug. 3, 1953, *M. McKay* (corr. JHS). RENFREW: Barron River, McKay Tp., Aug. 25, 1937, *W. W. Judd* (TRT); shore line of Golden Lake,

July 25, 1946, *H. Lloyd* (DAO). RUSSELL: margin of Bear Brook near Leonard, July 12, 1941, *H. A. Senn 2004* (DAO). SIMCOE: vicinity of Barrie—Spotton (41). WATERLOO: edge of marsh, near Branchton, Aug. 11, 1940, *F. H. Montgomery 725* (DAO, McM, OAC); Galt, July 27, 1912, *W. Herriot* (OAC). WELLAND: Niagara Falls, Aug. 25, 1900, *H. Twohy* (QU); Lyon's Creek in Crowland Tp., July 19, 1948, *Bert Miller 281* (McM); roadside ditch, Welland, Sept. 12, 1947, *E. G. Anderson 817* (DAO); Point Abino, Sept. 6, 1941, *J. H. Soper* (s.r.). WENTWORTH: swamp land, Red Hill, near Hamilton, Aug. 15, 1943, *R. S. Haines* (McM); marshy ground, Binkley's Hollow, Aug. 13, 1895, *J. M. Dickson* (McMHA); marshy ground, Cherry Beach, L. Ontario, July 24, 1941, *J. H. Soper 2763* (TRT); marsh near Millgrove—Logie (11).

ADDITIONAL RECORD: According to John Macoun (12) this species was ". . . common in Ontario, extending west to the Sault Ste. Marie." (just off our map at the northwest corner). We have no proof of its occurrence that far north and no other reports for Algoma District. The report is plausible, however, since button-bush has been reported by Billington (17), in Michigan (see his map, op. cit., p. 208) north to a latitude almost equal to that of Sault Ste. Marie.

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KEY TO "SEEDS" OF FLESHY FRUITS[1, 2]

ERIKA E. GAERTNER[3]

THE KEY presented is artificial. It is aimed to give information about plant sources where nothing but the "seed" is available. It is based on the descriptive data of Hoefle and personal study of the "seeds". The key can be used to separate the seeds of most of the fleshy-fruit-bearing plants of North Eastern America. The classification followed for the various plants is that of the 8th edition of Gray's Manual.

A seed, technically speaking, is the fertilized and matured ovule only. The fruit consists of the matured ovary wall, or *pericarp*, and encloses the seed(s). Fruits can be separated into dry and fleshy, depending on the nature of this pericarp. In some fleshy fruits other parts besides the ovary wall contribute toward the "meaty" part of the "fruit". The strawberry includes the fleshy receptacle into which individual fruits are embedded; pears, apples, etc., include fleshy parts of the perianth, as does also the rose. These are only a few examples. For our purposes, where only the seeds of fleshy fruits are considered, we have established our main division depending on the nature of the structure examined, i.e., if it is only the seed according to the botanical definition, or if a part or all of the pericarp is included. If the former is true, the hard part on the outside is the *seed coat*, and when it is removed we are exposing the *endosperm* or *cotyledons* (seed leaves) of the seed. If the latter is true, we probably have a *stone* or an *achene*. The stone or pit is the hard centre of a peach; upon cracking we find the seed with its seed coat inside (Plate I, Fig. 2). An achene is a dry fruit, such as a sunflower "seed". The pericarp is dry and leathery; again, upon cracking, we find a seed in its seed coat (Plate I, Fig. 3).

The *endosperm* is the part of the seed, outside of the embryo, upon which the developing seedling might draw for its nourishment; it is rich in reserve materials (i.e., starch). Seeds are called *albuminous* if they possess an endosperm and *exalbuminous* if they lack endosperm.

The *longitudinal axis* is the axis from the *hilum* (scar where seed was attached in fruit) to the opposite end (straight line). The *horizontal axis* is at a right angle to it; *depth* represents the 3rd dimension (Plate I, Fig. 1). *Striate* means marked with fine longitudinal lines or streaks. *Foliaceous* means leaf-like.

[1]Manuscript received June 9th, 1953.

[2]This work was supported in part by the Research Council of Ontario.

[3]Formerly, Department of Botany, McMaster University, Hamilton, Ontario; present address, Forest Experiment Station, Chalk River, Ontario.

The writer is indebted to Dr. W. C. Muenscher of Cornell University, Ithaca, New York, for the loan of all seeds studied. She also wishes to thank all her colleagues and students for their interest and time spent in testing the key.

KEY

A "Seeds", when separated from the fruit, covered by a seed coat plus a pericarp (mostly stone fruits or drupes, or achenes of berry-like fruits)
  B Stone with 2 or 3 cells
    1. Shallow longitudinal groove on both sides dividing the 2 cells, shape of stone cylindrical ellipsoid ($v/h = 1.9$) *Berchemia scandens*
    1. If provided with a shallow longitudinal groove dividing the cell, shape of stone not cylindrical ellipsoid; 2 or 3 cells *Cornus*
  BB "Seed" with one cell only
    2. Stone cup-shaped, boat-shaped or curved into a crescent or ring
      3. Stone cup-shaped or boat-shaped
        4. Stone hollowed out on one side like a cup 17.6–22.0 mm. long ($v/h = 1.1$) *Calycocarpum lyoni*
        4. Stone with one side convex, smooth and shiny; one concave and rough with a rim giving it a boat-like appearance; elliptical to oval; 2.1–2.6 mm. long *Callicarpa americana*
      3. Stone curved into a crescent or a ring
        5. With one edge straight, shaped like half of a heart *Panax quinquefolius*
        5. Without a straight edge
          6. Stone 6.4–8.2 mm. long, horseshoe-shaped, with three transversally wrinkled ridges *Menispermum canadense*
          6. Stone curved into a closed spiral, with crested surface *Cocculus carolinus*
    2. "Seed" not cup-shaped, nor curved into a crescent or a ring
      C Stones with the horizontal axis longer than the vertical one *Rhus*
      CC "Seeds" with the horizontal and vertical axis either equal, or the vertical one longer
        D Vertical cross section more or less isodiametric ($v/h = 0.8$–1.4), "seeds" either round or flattened, sometimes with a beak
          E The two diameters (v & h) nearly equal, but the achene distinctly 3 or more angled, flat *Morus*
          EE "Seeds" not angled
            F Stones round, or round with a beak at one end
              1. Stone more or less bean-shaped or elliptical and plump, slightly smaller at one end, surface smooth, slightly uneven; embryo stalked *Rhus*
              1. Stone and embryo not as above
                2. What appears as a stone is in reality a naked seed with an extremely hard endosperm; fine ridges radiating from the hilum *Caulophyllum thalictroides*
                2. True stones
                  3. No distinct ridges or grooves evident
                    4. Length of stone 2.5–3.9 mm.; surface granular or tuberculate; seed exalbuminous *Myrica*

4. Length of stone 4.7–5.5 mm.; surface rough; seed albuminous *Symplocos paniculata*

3. Ridges or grooves evident

5. Stones both ridged and grooved, with a small sharp tip; ridges usually radiating from an elevated region into which the hilum is imbedded; hilum evident as a circular opening *Prunus*

5. Stone either distinctly ridged or grooved without a sharp tip; without the arrangement around the hilum as indicated above

6. Stones ridged

7. A vertical ridge encircling stone; surface smooth or granular *Sassafras albidum*

7. Ridges several, either well defined or formed by adherent vascular bundles only

8. Four main ridges; the network or ridges well defined and sharp; stone nearly spherical, 5.8–7.5 mm. long *Celtis occidentalis*

8. Ridges several, branching, formed by the adherent vascular bundles; 4.8–5.6 mm. long *Commandra umbellata*

6. Stones distinctly grooved

9. 4 to 6 irregular grooves radiating from the poles; surface rough granular *Geocaulon lividum*

9. Stone with a single, y-shaped groove *Viburnum dentatum*

FF "seeds" flattened ($h/d = 0.4 +$) or wedge-shaped

1. Stone ellipsoid or oblong in cross-section ($h/d = 0.4 +$)

2. Stone over 3 mm. long; laterally flattened, slightly swollen around the scar; surface dull, roughened to granular with microscopic lines in shell-like pattern; seed albuminous *Mitchella repens*

2. Stone at least 4.5 mm. long; markings different

3. Stones thick-walled and bony; with the ridges radiating from an elevated region into which the hilum is imbedded; hilum a circular opening; seeds exalbuminous *Prunus*

3. Stone relatively not as hard; longitudinal ridges and grooves present or absent, not in a definite order; position of hilum not as above; seed albuminous *Viburnum*

1. "Seed" wedge-shaped, flat or angled, or with the inner face keeled

4. Achene less than 2.5 mm. long, wedge-shaped or flat and variously angled *Morus*

4. Stone over 4.5 mm. long

5. Stone wedge-shaped, with a notch at thinner edge *Gaylussacia*

5. Stone with inner face keeled; undeveloped stones with a flattened rim; base obtuse, protruding slightly beyond the seed coat; dull, smooth, sometimes with scattered protuberances over the surface *Rhamnus caroliniana*

DD Vertical axis longer than the horizontal one; "seeds" oblong ($v/h = 1.4 - 1.8$) or elongate ($v/h = 1.9 +$)

G "Seed" wedge-shaped, half-ovoid, or triangular in cross-section (2 or more stones per fruit)

H Achene slightly flattened or wedge-shaped; with a notch or a slight beak

1. Achene over 2 mm. long, wedge-shaped; transversally wrinkled, with few to many bristles *Dalibarda repens*
1. Achene less than 2 mm. long, roundish, with a network of veins *Fragaria*

HH Not as above

1. Stone half-ovoid *Symphoricarpos*
1. "Seed" wedge-shaped or triangular in cross-section, if ellipsoid, with one straight edge
2. Stone over 6 mm. long
3. Stone six-ribbed, five prominent ribs on back, and one on the face; furrows with fibrous webbing *Triosteum aurantiacum*
3. Ridges not in the above arrangement; without fibrous webbing *Crataegus*
2. "Seed" less than 6 mm. long
4. Stone with an irregular protuberance on the straight edge; surface finely roughened, granular *Empetrum nigrum*
4. Stone without the protuberance on the straight edge
5. "Seed" with a network of ridges or with cross-wise markings or ridges
6. With a net-work of ridges, which are sometimes broken, forming pits; stone round to oblong in cross-section (h/d = 0.8 — 1.8) with one straight edge, which is sometimes ridged
7. "Seed" less than 1.5 mm. long *Duchesnea indica*
7. "Seed" more than 1.5 mm. long *Rubus*
6. Not as above
8. Cross section somewhat triangular with the outer surface rounded; transverse markings irregular and warty *Sambucus*
8. Cross section ellipsoid or lanceloid with one edge straight; dull; cross-wise roughened with numerous fine lines or ridges; or rough, warty or irregular tuberculate *Aralia*
5. Stone with more or less distinct longitudinal ridges
9. Stone 5.6–6.1 mm. long with several longitudinal ridges branching and uniting; dull and rough *Rhamnus lanceolata*
9. Stone less than 5.5 mm. long; not as above
10. The straight edge thin, with one to three light-coloured ridges on the curved thicker edge; surface rough, coarsely granular; one or both ends acute *Arctostaphylos uva-ursi*
10. Ridge one and central, with two sides sloping from it, otherwise usually indistinct, sometimes lacking; stone smooth or longitudinal striation might be present on the curved back
11. Stone 3.7–4.4 mm. long, 2.5–3.0 mm. wide; 1 side rounded

and 2 sides flat, triangular in cross section; surface dull, roughened; with an indistinct longitudinal ridge or striation on rounded back *Nemopanthus mucronata*

11. Stone 3.3–4.0 mm. long, 1.6–2.3 mm. wide; one side convex, two sides sloping from a central ridge, or one side rounded and one side flat; surface smooth, usually with one low ridge in the centre of the rounded back *Ilex verticillata*

GG "Seed" either round ($h/d = 0.8 - 1.3$) or oblong to ellipsoid in cross section ($h/d = 1.4 +$)

I "Seed" round in cross section

1. One or several ridges encircling the "seed"
2. Stone with sharp longitudinal ridges formed by the coalescence of the individual nutlets *Arctostaphylos*
2. Achene smooth and shiny, encircled by a crinkled ridge; a fringe of hair on either side *Calycanthus floridus*
1. Not as above
3. Stone over 12 mm. long; network formed by six main longitudinal veins and several lesser ones *Chionanthus virginicus*
3. "Seed" less than 12 mm. long; veins not in the above arrangement
4. Achene polyhedral, i.e., with several flat sides arranged at an angle; edges more or less round *Rosa*
4. Not as above
5. Stone dull, smooth, with a shallow groove on back; base acute *Rhamnus cathartica*
5. Stone without any grooves, with or without one or several ridges; ridges sometimes not clearly distinct in elevation, but recognizable by their colouring in cross section of the hard pericarp
6. Ridge solitary or absent
7. Stone over 7.5 mm. long; dull, granular, with or without a vertical ridge encircling the stone; one or both ends pointed *Lindera benzoin*
7. Stone less than 7 mm. long; ridge solitary along one side of the stone
8. Stone ellipsoid to globose; apex acute, base more or less rounded; colour a gradation from silvery to dark brown *Daphne mezereum*
8. Stone ovoid; apex hooked, base acute; colour bronze, sometimes black *Dirca palustris*
6. Ridges several
9. Ridges 6–8, sometimes not very distinct in elevation, but very light and easily observed in the cross section of the pericarp; inner lining of walls fibrous *Elaeagnus*

9. Ridges irregular and coarse; surface pitted *Crataegus monogyna*

II "Seed" ellipsoid in cross section (h/d = 1.4 +)

1. "Seeds" over 7 mm. long
2. Structure examined an achene; ovoid to angular ellipsoid, laterally flattened with a notch at one end; surface finely striated lengthwise; 7.6–10.6 mm. long; seed exalbuminous *Maclura pomifera*
2. Structure examined a stone with different characteristics
3. Stones with definite ridges or grooves
4. Stones ridged, 1-several ridges radiating from the elevated part around the hilum; seed exalbuminous *Prunus*
4. Stone with 8 or more longitudinal ridges; seed albuminous *Nyssa*
3. Stone without ridges; roughly granular *Viburnum prunifolium*
1. "Seeds" less than 7 mm. long
5. Achene with a longitudinal groove dividing it into two halves of unequal length *Shepherdia*
5. Stone with different characteristics
6. Stone flat, not over 1.5 mm. thick *Aralia*
6. Stone more than 1.5 mm. thick
7. Stones heart-shaped; not more than 5 mm., usually less, long; inner face keeled; longitudinal ridge on dorsal face *Rhamnus alnifolia*
7. Stones not as above, at least 4.8 mm. long
8. Stone with several longitudinal ridges branching and uniting; dull and rough *Rhamnus lanceolata*
8. Stones not as above *Viburnum*

AA Seeds when separated from the fruit covered by seed coat only (true seeds)

1. Seed over 9 mm. long
2. Seed over 15 mm. long; albuminous
3. Seed 23 mm. long, and 17 mm. wide; compressed, elliptical, oval; surface smooth, endosperm ruminated *Asimina triloba*
3. Seed 15.7–19.4 mm. long, 7.8–11 mm. wide; flat, linear-elliptical, uneven in thickness; a groove on the edge encircling the seed; surface granular, covered with fine vertical lines; endosperm hard and cartilaginous *Diospyros virginiana*
2. Seed not over 15 mm. long; exalbuminous
4. Seed globular or broadly ovoid
5. Surface smooth and somewhat shiny with tuft of hair at smaller end; embryo with foliaceous cotyledons *Sapindus drummondi*
5. Surface, when dry, wrinkled; prominent tubercle or stalk-like structure at one end; embryo large and fleshy *Peltandra virginica*
4. Seed oblong (v/h = 2 or more); surface lustrous, smooth or finely granular; embryo straight *Pyrus communis*

1. Seed less than 9 mm. long
  6. Seed with a prominent ring-like double ridge or fold on one side of the seed; glossy with high polish; endosperm hard; embryo minute *Hydrastis canadensis*
  6. Seed not as above
    H Seeds flattened or lens-shaped; nearly round in circumference (v/h = 0.8 — 1.4) or with one edge curved and the other straight with a slight notch at the smaller end
      1. Seeds more than 1 mm. thick
        2. Seed rounded or angular, bean- or kidney-shaped; glossy, with a dark coloured scar at one end; if kidney-shaped, scar along one side *Convallaria majalis*
        2. Seed not as above
          3. Seed lens-shaped, with a light-coloured peg-like structure in a notch at the margin; highly polished, frequently with thin, transparent layer adherent to seed coat; embryo coiled around endosperm *Phytolacca americana*
          3. Seed unsymmetrically ovoid; coarsely and densely pitted; without a peg-like structure in the notch *Atropa belladonna*
      1. Seeds less than 1 mm. thick
        4. Seed with one edge curved, the other straight with a slight notch at the smaller end; 4.7–5.3 mm. long *Podophyllum peltatum*
        4. Seed ovate with a protuberance or beak at smaller end or nearly circular and lens-shaped; not over 3.5 mm. long
          5. Seed ovate with a protuberance or beak at smaller end, 2.4–2.6 mm. long; surface roughened *Phoradendron flavescens*
          5. Seed nearly circular and(or) lens-shaped
            6. Seed coarsely pitted; hilum in a deep notch in the middle of one edge *Lycium halimifolium*
            6. Seeds very finely pitted or granular; hilum near one end or in a shallow notch on one edge
              7. Seed dull; pits with glistening glands or glandular hairs *Physalis*
              7. Seed shiny; pits if present shallow without glands *Solanum*
    HH Seeds not distinctly flattened or lens-shaped
      I Seeds more or less isodiametric (not necessarily round)—(v/h and h/d = 0.8 — 1.4) or at least round in vertical cross section (v/h = 0.8 — 1.4)
        J Seed with an even outline; not triangular, triangular-obovate nor heart-shaped
          1. Seed 6.8–8.6 mm. long; globose, with a saucer-like depression at one end, depressed and somewhat shrunken *Symplocarpus foetidus*
          1. Seed less than 6 mm. long; with other characters
            2. Seed with a longitudinal furrow close to one edge of the seed; wrinkled appearance of seed resembling a brain; seed triangular to circular in cross section *Hedera helix*

2. Seed not as above
   3. Seed with the horizontal axis sometimes longer than the vertical one; often angled, variously compressed or flattened, with a dark area around the hilum
      4. Seed 2.7–4.9 mm. long; if kidney-shaped, with a scar along one side; surface glossy *Convallaria majalis*
      4. Seed 2.8–3.5 mm. long; surface smooth, dull to semi-glossy *Polygonatum*
   3. Seed not as above
      5. Seed unsymmetrically ovoid, slightly flattened, especially toward the smaller end, edges rounded; scar to one side of the smaller end; coarsely and densely pitted *Atropa belladonna*
      5. Seed not as above
         6. Seed irregularly flattened, angular, ovoid, 3–5 sided; shining and smooth or roughened and slightly wrinkled; hilum not prominent *Clintonia*
         6. Not as above
            7. Seed-coat forming a much wrinkled, stalk-like structure at the larger end; surface roughened; seed 3.6–5.1 mm. long *Arisaema*
            7. Not as above
               8. Seed smooth, with one to several sides often flattened
                  9. Seed black, hilum light *Asparagus officinalis*
                  9. Colour of seed various, hilum prominent but not distinctly coloured (or black) *Smilax*
               8. Seed wrinkled, pitted or both
                  10. Caruncle present; seed with fine transverse lines and various longitudinal ridges *Trillium*
                  10. Caruncle absent
                      11. Seed coarsely wrinkled with linear pits; 3.0–4.4 mm. long *Smilacina*
                      11. Seed irregularly wrinkled with the hilum a circular, light-coloured area limited by, or surrounded by, a dark area at one end and a darker point at the other end; 1.9–3.2 mm. long *Maianthemum canadense*

JJ Seed somewhat triangular, triangular obovate or heart-shaped
1. Seed not more than 1 mm. long; somewhat triangular, angular or irregularly ovoid, and laterally compressed; glossy, translucent, with a high polish; endosperm fleshy *Gaultheria hispidula*
1. Seed more than 1 mm. long
   2. Seed with a longitudinal furrow close to one edge of the seed; wrinkled appearance of the seed resembling a brain; seed triangular to circular in cross section *Hedera helix*
   2. Seed not as above
      3. Seed variously flattened and (or) angled
         4. Seed with at least 2 sides triangular, variously flattened and

angled; surface wrinkled and glossy, the concave sides smoother than the rounded side; 2.8–3.6 mm. long *Medeola virginiana*

4. Seed with at least 2 or more sides flattened, part of 1 always convex; seed shining, smooth or rough and slightly wrinkled; 3.0–4.2 mm. long *Clintonia borealis*

3. Seed triangular-obovate or heart-shaped with a round oval to triangular area distinct on the convex side

5. Without a furrow from the characteristic area to base; surface dull; seed 4.6–6.3 mm. long *Vitis*

5. Seed with a ridge beginning at the base on one side, and ending in a furrow at the base on the other side, with the characteristic area between them

6. Surface glossy; seed 3.2–4.9 mm. long *Parthenocissus*

6. Surface dull; seed 4.5–5.0 mm. long *Ampelopsis*

II Seed oblong or elongate ($v/h = 1.4 +$)

K Seed round or oblong in cross section ($h/d = 0.8 - 1.8$)

L Seed variously-bent or hooked at the base with a more or less prominent notch

1. The base of seed turned to one side or hooked; surface with vertical lines: exalbuminous

2. Seed 2.4–3.0 mm. long; smooth with vertical lines *Pyrus* (Aronia)

2. Seed 3.0–4.6 mm. long; dull or glossy, with numerous woody, long lines *Amelanchier*

1. Ovoid, plump or oblong, often with one side flat or concave, the other rounded; convex, with a more or less prominent notch at one end; some with 2-3 irregular longitudinal ridges, the outer forming a margin and almost completely encircling the centre one; smooth, variously pitted or wrinkled; albuminous *Lonicera*

LL Seed without a bent base or more or less prominent notch

1. Seed coat forming a much wrinkled, stalk-like structure at the larger end; surface roughened; seed 3.6–5.1 mm. long *Arisaema*

1. Not as above

2. Seed with a caruncle; surface with fine transverse lines or ridges *Trillium*

2. Seed without a caruncle

3. Seed less than 1.5 mm. long and 1 mm. wide

4. Surface smooth or glossy; shape various, obovoid or angular *Gaultheria procumbens*

4. Surface variously roughened or wrinkled

5. Seed ovoid, not angled or flattened; surface finely reticulated with longitudinal lines or ridges *Arceuthobium pusillum*

5. Seed ovoid, obovate, often variously angled or flattened

6. Seed usually flattened, triangular or several-sided, or with one or both ends pointed; surface with a network of longitudinal lines or ridges *Vaccinium*

6. Seed ovoid, obovate, angled, with the edges blunt, or often winged; decidedly wrinkled and roughened *Ribes*
3. Seed more than 1.5 mm. long and 1 mm. wide
 7. With one to several longitudinal ridges or wrinkles, or with a raphe along one side; albuminous
  8. Longitudinal ridges or wrinkles several
   9. Seed 2.4-2.8 mm. long; ovoid, slightly curved, larger end retuse and truncate, often concave; dull; ridges low and long, etched, with many longitudinal grooves *Streptopus roseus*
   9. Seed 3.7-6.3 mm. long; ovoid or slightly wedge-shaped; glistening, with several longitudinal ridges or wrinkles *Ligustrum*
  8. With a single ridge or raphe along one side
   10. Seed cylindrical; basal half with longitudinal striations, upper half with pits or irregularly-shaped spots *Calla palustris*
   10. Surface not as above
    11. Seed ovoid to lanceloid; smooth, slightly wrinkled at either end *Celastrus scandens*
    11. Seed glossy or shining, granular, pitted or (and) wrinkled, but not in specific regions only; ovoid, plump, if somewhat flattened, slightly curved *Euonymus*
 7. Seed without a ridge; ovoid, dorsal face rounded, ventral face flat or slightly concave; surface roughened, minutely pitted *Berberis*

KK Seed variously flattened, angled or wedge-shaped
1. Seed with a wing-like margin, somewhat flattened, gloss-like in appearance; 4.1-4.6 mm. long; exalbuminous *Pyrus aucuparia* (Sorbus)
1. Seed without a wing-like margin, variously marked or sculptured
 2. Seed completely flat, slightly half-heart shaped, inner edge attenuated into a ridge with a slight notch near the smaller end *Podophyllum peltatum*
 2. Seed of various shapes not completely flattened
  3. Seed with at least one side rounded, shaped like a wheat kernel or variously flattened on the other sides; usually larger
   4. Seed shaped like a wheat kernel; 4.4-5.4 mm. long *Disporum lanuginosum*
   4. Seed laterally compressed, depressed, curved or wedge-shaped; 3-sided with 1 side rounded and 2 sides flat, or 4-sided with 1 side rounded, 2 sides flat and 1 side concave, with a groove on the concave side; a meshwork of fine ridges more prominent on the sides, 2.5-4.4 mm. long *Actea*
  3. Seed without the one rounded side; ovoid, obovoid, flattened or angled; either variously wrinkled or striated; usually smaller in size

5. Surface with either pits or striations, the pits in regular rows; ovoid, flattened, or plump-ovoid with one or both ends acute *Vaccinium*
5. Striations or pits lacking; seed much wrinkled or roughened *Ribes*

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EXPLANATION OF PLATES

An illustrated glossary of terms used in describing size, shape or structure of "seeds" or their parts.

PLATE I

FIG. 1. A diagram to illustrate the relationships between the three axes, vertical (V), horizontal (H), and depth (D): e.g. S(V/H = 0.8); T(V/H = 1.4); X(V/H = 1.8); Y(V/H = 2 +).

FIG. 2. Cross section of a drupe, showing the relationship between the fleshy (F) and bony part or stone (ST) of the pericarp and the seed (S) with its seed coat (SC).

FIG. 3. Cross section of an achene showing the relationship between the dry pericarp (DP), the seed (S), and its seed coat (SC).

FIG. 4. Shallow longitudinal groove (G) on both sides dividing the 2 cells (C) of the stone is shown in cross section (*Berchemia*).

FIG. 5. Ruminated endosperm (*Asimina*).

FIG. 6. Shaped like half of a heart (e.g. *Panax*).

FIG. 7. Concave on one side, convex on the other: boat-shaped with a rim (*Callicarpa*).

FIG. 8. Seed half-ovoid (*Symphoricarpos*).

FIG. 9. Single Y-shaped groove (*Viburnum dentatum*).

FIG. 10. Seed heart-shaped, with a ridge beginning at the base on one side and ending in a furrow at the base on the other side, with a round oval area between them (e.g. *Parthenocissus*).

PLATE II

FIG. 11. A seed with a prominent, ring-like, double ridge (*Hydrastis*): A top view of the ridge.

FIG. 12. Achene with a long groove dividing it into two halves of unequal length (*Shepherdia*).

FIG. 13. Region around the hilum raised and ridges radiating from it (*Prunus*).

FIG. 14. Caruncle (e.g. *Trillium*).

FIG. 15. Seed coat forming a stalk-like structure at the larger end (e.g. *Arisaema*)

FIG. 16. Seed with a peg-like structure in a notch at the margin (*Phytolacca*).

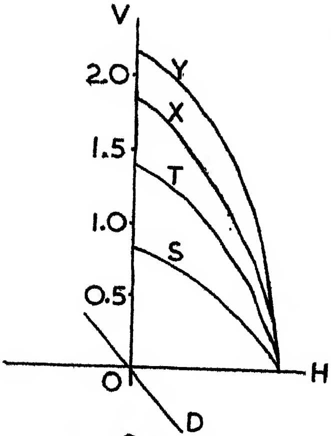
FIG. 17. Notch at the thinner edge (*Gaylussacia*).

FIG. 18. Irregular protuberance on the straight edge (*Empetrum*).

FIG. 19. A notched base (e.g. *Amelanchier*).

FIG. 20. Base of seed protruding slightly beyond the seed coat (e.g. *Rhamnus caroliniana*).

PLATE I



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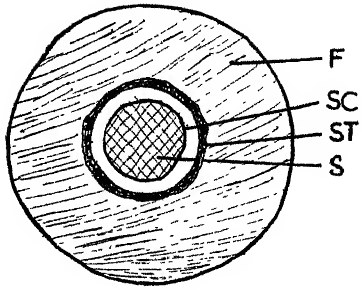

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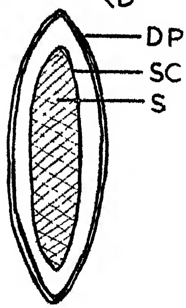

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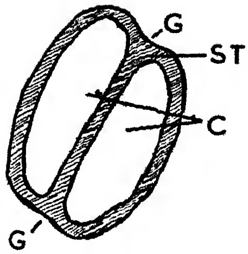

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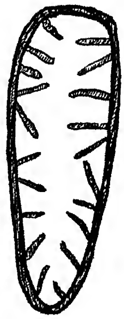

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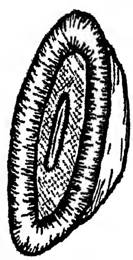

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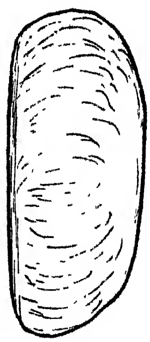

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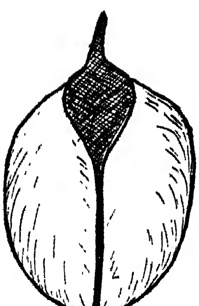

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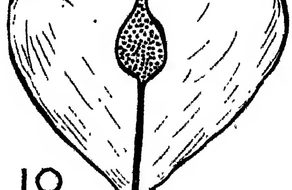

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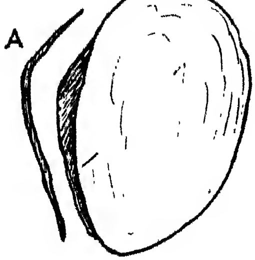

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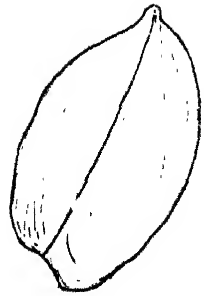

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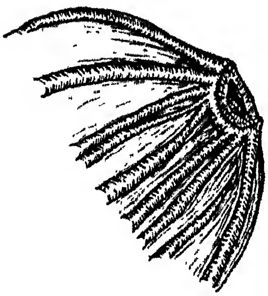

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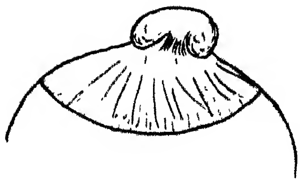

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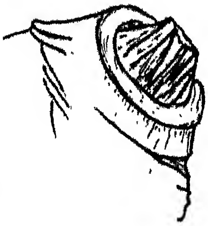

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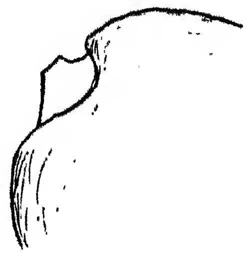

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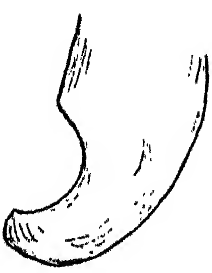

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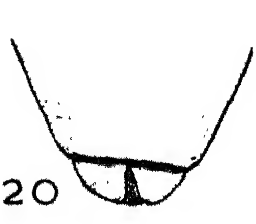

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SUMMER BIRDS OF WESTERN ONTARIO[1]

L. L. SNYDER[2]

INTRODUCTION AND ACKNOWLEDGMENTS

THE DESIRABILITY of further ornithological surveys in western Ontario became evident after the introductory work conducted in Rainy River District during the summer of 1929 (Snyder, 1938). In order to trace the eastern limits of certain campestrian elements and to ascertain the frequency and northward spread of numerous characteristically southern forms, it was necessary to make observations and collections from a series of stations well distributed over the region immediately to the north. The fact that both the Canadian National and Canadian Pacific Railways pass through this section of the Province facilitated the undertaking. Specimens and data were obtained by members of the Museum staff in the summers of 1937, 1947 and 1949. In addition to the information gathered directly by Museum personnel, several MS reports pertaining to the birds of the region were generously made available by experienced observers.

Acknowledgment is especially due to members of the staff of the Royal Ontario Museum of Zoology and Palaeontology—Messrs. T. M. Shortt, the late C. E. Hope and J. L. Baillie—for their respective contributions to the field surveys. Also thanks are gratefully extended to the following for information supplied: Mr. Leslie Paterson, of Kenora; Dr. Jack Satterly, of Toronto; Mr. B. W. Cartwright, of Winnipeg; Dr. A. E. Allin, of Fort William; and Dr. Wm. Rowan of Edmonton. Minor reports by many individuals have been received, assessed and included when they have added distributional details. For the sake of brevity names are seldom used in the text, the author accepting responsibility for all occurrence records included. However, he expresses his thanks to all contributors.

MUSEUM FIELD SURVEYS

During the summer of 1937 Mr. T. M. Shortt and the writer carried on field work along the Canadian Pacific Railway, from the Manitoba boundary eastward across southern Kenora District to within the boundaries of Thunder Bay District. Three distinct camps were established as follows: Ingolf (May 31 to June 14), Wabigoon (June 14 to July 5) and Savanne (July 5 to July 17).

During a part of the summer of 1947 Messrs. C. E. Hope and T. M. Shortt organized a general faunal survey for the Museum along the Canadian National Railway to the north. Two camps were established in southern Kenora District: Sioux Lookout (June 22 to July 9) and Malachi (July 9 to August 6).

In the summer of 1947 (from June 15 to 21) and again in 1949 (May 23 to June 13) Mr. J. L. Baillie visited the Kenora area briefly, making excursions to several sections of northern Lake-of-the-Woods and contiguous waters. His June observations and the specimens collected are included in this report.

[1]Manuscript received Jan. 8th, 1953.

[2]Curator, Division of Ornithology, Royal Ontario Museum of Zoology and Palaeontology.

OTHER SOURCES OF DATA

Mr. Paterson's records pertain largely to the Kenora area and cover the period between 1929 and 1949. Dr. Satterly visited the Dryden area in the summer of 1939 and the townships about Dinorwic Lake (Southworth, Hartman north to Laval and Brownridge) in the summer of 1940. Although his work was geological (Satterly, 1943) he kept a record of bird species observed during the summer months of June, July and August. Mr. Cartwright made observations near Minaki and White Dog Rapids in mid-August, 1937. Dr. Allin has visited the region occasionally in summer and made casual observations there. Dr. Rowan kindly indicated in MS definite Ontario occurrences undistinguished in his reports on a borderline area (Rowan, 1922a; 1922b).

REPORTS ON ADJACENT AREAS IN ONTARIO

A published list of the summer birds of the Madsen area (Goodwill, 1942) has added to our knowledge of the western portion of the Province. This area lies to the north of the region covered by the present report. A faunal report for western Rainy River District (Snyder, 1938) concerns an area virtually contiguous to the area covered by the present report. Concerning areas to the east, there is a report on the summer birds of Lake Nipigon (Snyder, 1928), a bird population study of a portion of the same area by Kendeigh (1947), and a list of the breeding birds of the region of Thunder Bay, Lake Superior, by Dear (1940).

ANNOTATED LIST

The sequence of species and the Latin names used in the following report follow the "Check-List of North American Birds" published by the American Ornithologists' Union in 1931 and the "Supplements" which have appeared subsequently in the *Auk*. Measurements of specimens are in millimetres. Accounts of occurrences validated by specimens include a summarized total. Those based on a single sight record include the name of the observer.

Gavia immer. COMMON LOON.—Generally distributed through the lake country covered by this report with considerable irregularity in local frequency. At Ingolf, observed rarely (one or two, on four days out of twelve) on Long Pine and Macara Lakes. None was seen on that portion of Wabigoon Lake adjacent to the Museum's camp. Here the bay water was often turbid. However the loon was observed on this lake near Dryden and it occurs on Dinorwic Lake which is essentially a part of the same basin. A characteristic breeding bird of the rock-rimmed waters of northern Lake-of-the-Woods where from three to six were recorded on each of several excursions made thereon. A flightless young was observed 15 miles east of Kenora on July 24, 1949. One or two were noted on four days out of twenty at Sioux Lookout and from one to six were recorded daily during the two weeks at Malachi. These latter observations included young of the year.
Specimen: 1 adult (bones).

Colymbus grisegena. RED-NECKED GREBE.—The population of this species appears to centre largely around Lake-of-the-Woods. As many as 13 were observed near Kenora on June 16, 1947. In no sense were these birds colonized yet occasionally two pairs were found in close proximity. Two nests with birds in attendance were observed on June 16, 1947, six miles southwest of Kenora; one nest with five eggs was collected on June 6, 1949, at Thompson's Island. Also found nesting on Allie Island on June 19, 1947, and at Labyrinth Bay near Shoal Lake Narrows on June 5, 1949. A lone bird was observed on a small marsh near Redditt on June 3, 1949. An individual was seen on Longbow Lake in mid-summer, 1949. Reported present near Dryden on August 31, 1939, and also on Dinorwic Lake during early June, 1940. Specimens represent the New World form, *C. g. holbollii.*
Specimens: 2 adults.

Podilymbus podiceps. PIED-BILLED GREBE.—A fairly common breeding bird in the vicinity of Kenora. A specific breeding record from there concerns an adult with young observed on August 11, 1943. Found established in marshes near Wabigoon where from one to three adults were noted daily. Young, newly hatched, were observed there on July 1, 1937.

Pelecanus erythrorhynchos. WHITE PELICAN.—A small breeding colony established on the southern boundary of the region covered by this report (on Dream Island in Lake-of-the-Woods, summer of 1938) is recorded by Roberts (1938). In June, 1947, five white pelicans were observed associated with cormorants on a rock near Garden Island in the south part of Shoal Lake which is essentially a part of the Lake-of-the-Woods. Inquiry of fishermen elicited the report that a pair of these birds had been seen on the same rock through the summers of 1944 and 1945.

Phalacrocorax auritus. DOUBLE-CRESTED CORMORANT.—The recent growth of the cormorant population (*P. a. auritus*) on Lake-of-the-Woods has produced conflict with the commercial fisheries. A fisherman on the lake, who had been there since 1908, stated that cormorants first had nested on Five Islands about 1927 (once called "Crow Duck Islands") and that they had spread from there since 1941. A total of 1,432 nests was counted on northern Lake-of-the-Woods islands in 1947 and 1,171 in 1949. The largest colony was situated on Silver Fox Island in Shoal Lake. It contained 447 nests. A colony nested on a rock in Clay Lake about 10 miles north of Quibell, in the summer of 1947.
Specimen: 1 adult.

Ardea herodias. GREAT BLUE HERON.—Observed occasionally at Ingolf. Reported as breeding in the northern Lake-of-the-Woods region, one colony being described as situated on an island at the northern end of Shoal Lake known locally as Blue Heron Island. Observed at High Lake, north of Indian Bay, in the summer of 1920, and at Echlin's Island, near Kenora, in August, 1930. We observed the species occasionally at Wabigoon and were informed by local residents that a colony was once established near there, on Thunder Lake. This colony disappeared after 1937. A breeding colony was established in the Dryden area of Wabigoon

Lake in June, 1939. Noted regularly around Dinorwic Lake in 1940. One was observed at Savanne on July 13, 1937, and one was recorded on July 6, 1947, at Sioux Lookout. Records from Malachi, Minaki and White Dog Rapids indicate the presence of the species in the more northerly portion of the region concerned, at least after mid-summer.

Botaurus lentiginosus. AMERICAN BITTERN.—Sporadically distributed in the region. Found in the Ontario portion of Indian Bay of Shoal Lake and a rather common summer resident of the Kenora region. We noted from one to three daily from our camp at Wabigoon, in suitable marshy areas on Wabigoon Lake and at the forty-acre "beaver meadow" four miles north of the village. Two young birds were noted at Wabigoon on July 4, 1937. Observed commonly during the first two weeks of June, 1940, on Dinorwic Lake. Two were recorded by the Museum's field party at Sioux Lookout on July 5, 1947, both on Pelican Lake.

Chen caerulescens. BLUE GOOSE. The inclusion of this species as a summer bird of western Ontario is based on the observation of a lone bird (Satterly) on June 8, 1940, at Dinorwic Lake. The characteristic colour pattern of an adult of this species was noted in detail. Although the region is not remote from the line of flight of this species on migration, the time of occurrence is undoubtedly irregular and suggests that the bird was defective.

Anas platyrhynchos. MALLARD. One of the more common breeding ducks of the region. Found in the Ontario portion of Indian Bay during the summer of 1920, though scarce. Observed regularly on Lake-of-the-Woods, where breeding records were established (Allie Island, female with small young, June 20, 1947; female with four young at Kenora on August 10, 1943; two young of the year observed 20 miles east of Kenora on July 26, 1949). Other occurrences pertain to Echlin's Island near Kenora in 1930; Wabigoon in 1937 (female with nestlings, June 26); and several noted at the northern extremity of Dinorwic Lake. A nest with eggs was observed on June 10, and downy young on June 12 and July 10, in the Dryden area in 1939. The species was not uncommon on Dinorwic Lake in June, 1940, where a nest with six eggs was found on June 17. Young just out of the nest were observed in Southworth Township on June 13, 1940.

Anas rubripes. BLACK DUCK.—One observed on August 18, 1937, at White Dog Rapids (Cartwright) approximately ten miles north of Minaki. Although the species is expanding its range in this general part of the continent—in Minnesota (Roberts, 1932), in Thunder Bay District of Ontario (Dear, 1940) and in Manitoba (Cartwright MS)—it has not yet effectively invaded this portion of Ontario as a summer resident.

Anas acuta. PINTAIL.—The status of this species in the region is precisely like that of the baldpate. Obviously western Ontario is marginal summer range of the species. It is a regular but rare summer resident of the Kenora area. Three at Thompson's Island, south of Kenora, on June 6, 1949.

Anas discors. BLUE-WINGED TEAL.—A rare summer resident of the region. A drake was seen in flight over Long Pine Lake at Ingolf on June 4, 1937. A male collected was one of a pair flushed in a small marsh at Keewatin on June 3, 1949. Observed on Dinorwic Lake during the first half of June, 1940.
Specimen: 1 adult.

Mareca americana. BALDPATE.—On June 5, 1949, a baldpate was observed at Galt Island on Shoal Lake and on the following day four were noted at Thompson's Island near Kenora. The status of these individuals is uncertain, that is, they may have been belated migrants, but long-period observations in the region indicate that they are rare but regular summer residents of the Kenora area.

Aythya collaris. RING-NECKED DUCK.—Observed occasionally in June, 1947, and 1949, at Thompson's Island and Black Sturgeon River, respectively. One to four recorded daily near Wabigoon from mid-June to early July, 1937.

Aythya affinis. LESSER SCAUP.—A rare summer resident of the region. One recorded twice at Ingolf, June 10, and June 11, 1937. A pair observed six miles southwest of Kenora on June 16, 1947. The species was noted rarely on Dinorwic Lake during both June and July, 1940.

Bucephala clangula. COMMON GOLDEN-EYE.—A common breeding duck of the region. The latest summer date on which a male was observed is June 17, 1947. Summer occurrence records include Ingolf, Shoal Lake, Labyrinth Bay, Allie Island, Black Sturgeon River, Thompson's Island, Kenora, Dryden, Wabigoon, Dinorwic Lake, Savanne, Sioux Lookout and Malachi. Reported as notably numerous at Dinorwic Lake during the first two weeks of June,' 1940. Specific breeding records based on young of the year include: One with four young at Allie Island, June 20,1947; three broods observed at Longbow Lake on July 28, 1949; downy young on Dinorwic Lake, July 2, 1939 and four broods (15, 6, 2 and 7) observed there on June 14 and 15, 1940; two downy young at Sioux Lookout July 4, 1947; six well-developed young at Malachi on July 16, and one young of the year observed at the same station on August 5, 1947. It seems evident that the common golden-eye is the most common and generally distributed breeding duck in this part of the province, the status being challenged only by the mallard.

Lophodytes cucullatus. HOODED MERGANSER.—A rare summer resident of the region. A pair was noted at Shoal Lake on June 5, 1949; two females were observed near Kenora on June 16, 1947, and a female was seen at Allie Island on June 20 of the same year. Two were observed on Longbow Lake, east of Kenora, in mid-summer, 1949, and the species was listed for Minaki on August 17, 1947.

Mergus merganser. COMMON MERGANSER.—Not uncommon for the region as a whole. June 17 (1937) is the latest summer date on which a male was observed (Shoal Lake). Summer occurrences include: Ingolf (two recorded on three days out of twelve); Allie Island and Echlin's Island in northern Lake-of-the-Woods; Laval Township north of Dinorwic Lake; Malachi and Minaki. Five breeding

records are as follows: A nest at Sioux Lookout, situated beneath a tent platform on the property of the Ontario Department of Lands and Forests, in 1947 (the female was on the nest on June 26, and June 28 the eggs had hatched); a family of nine young observed at Kenora on August 16, 1943; a downy young collected at Malachi on July 9, 1949; a nest found in the chimney of a cottage near Ignace, on June 11, 1950 (two of the ten eggs were forwarded to the Museum and two weeks later a second laying of eight eggs had been deposited); a family of nine young observed in the Dinorwic area on August 12, 1940.
Specimen: 1 natal down.

Mergus serrator. RED-BREASTED MERGANSER. A rare summer resident of the region. A pair was observed on Shoal Lake on June 5, 1949, and a female was identified at Allie Island on June 19, 1947. The species was observed in early June, 1940, on Dinorwic Lake.

Cathartes aura. TURKEY VULTURE. The regular occurrence of this species in western Ontario is of sufficient interest to justify enumeration of a number of records (see Allin, 1944). The earliest historic record of occurrence concerns two young found in a rock crevice at Poplar Bay in July, 1911. Baillie and Harrington (1936–37) have published a breeding record of the turkey vulture for Thompson's Island, near Kenora (two well-developed young, in July, 1919). Occurrence was reported for High Lake, Ontario, on June 30, 1920. An individual was observed near Ingolf on June 1 and two at the same place on June 9, 1937. A clutch of two eggs was found on the ground beside a fallen log near the lakeshore at Bottle Bay, Lake-of-the-Woods, in mid-July, 1937. On July 18 of the same year a lone turkey vulture was observed feeding on a dead fish on the shore of Manitou Lakes, some thirty miles south of Wabigoon. Also in 1937 "at least two" turkey vultures were observed near Minaki on August 18. An account of a "Turkey Buzzard" being shot at Wabigoon in mid-August, 1941, appeared in the *Fort William Times* for August 29 of that year. During the summer of 1942 two young were observed near Hawk Lake (twenty miles east of Kenora). In 1947 the species was observed occasionally at Malachi (one or two, on four days during a two weeks stay). Also in 1947 five turkey vultures were observed on Dominique Island (Shoal Lake) on June 17, two at Shoal Lake Narrows on the same day, one at Allie Island on June 19, and two at the latter place on June 20. In August, 1948, two vultures were shot at Sioux Narrows, approximately thirty miles south-east of Kenora. Both were forwarded to the Museum where one was preserved as a skeleton. In 1949, eight turkey vultures were observed in eastern portions of Shoal Lake on June 5; one on Thompson's Island on June 6, and one at Kenora on June 13. Six were seen at Storm Bay in June, 1949. They were feeding on dead fish. Fish carrion, particularly that available from the fishing industry, may have favourably effected the distribution and numbers of the species in this region in recent years. Opinion of residents suggests that the turkey vulture has increased and spread during the past twenty years. With respect to its spread one additional record may be mentioned though it concerns territory beyond that covered by this report. During the summer of 1948 a flock of twelve turkey vultures was observed,

by representatives of the Department of Lands and Forests, feeding on commercial fishery offal at Sydney Lake. This lake is north of the English River, nearly sixty miles north of Kenora.

It is possible to refer the turkey vulture of this area to the race *C. a. teter* of Friedmann (1933) on the basis of measurements from three specimens, one taken at Sydney Lake and two taken at Sioux Narrows, Lake-of-the-Woods. The average measurements of these are: Chord of wing 493; tail 258; chord of culmen, from cere 24.5; tarsus 65.
Specimen: 1 adult.

Accipiter gentilis. GOSHAWK.—Records of two summer occurrences are available; both concern adults—one observed at Savanne on July 14, 1937, and the other at Malachi on July 19, 1947.

Accipiter striatus. SHARP-SHINNED HAWK.—A tabulation of records includes individuals observed on two occasions during the summer of 1920 at High Lake in Ontario; one bird observed at Ingolf on June 2, 1937; two at Kenora June 5, and June 8, 1949, respectively; two individuals noted at Wabigoon on July 23 and July 25, 1937, respectively, and, one on July 19, 1947, at Malachi.

Accipiter cooperii. COOPER'S HAWK.—An adult female was observed at close range by the writer on July 5, 1937, west of Barclay near Dryden. The nearest known occurrences are those of Snyder (1938) for western Rainy River District to the south.

Buteo jamaicensis. RED-TAILED HAWK.—Occurs throughout the region, not uncommonly in some localities. From one to three noted every few days at Ingolf; almost daily, and more commonly at Wabigoon (one to seven), and rarely at Savanne, all in 1937. One noted at Kenora on June 8, 1949, and one near Vermilion on June 21 of the same year. Observed rarely on Dinorwic Lake during the first two weeks of July, 1940. From one to five, almost daily, at Malachi in 1947.

It seemed probable that at least three pairs of red-tails nested within a five-mile radius of the Malachi camp. Two nests were actually found. The first was situated 30 feet up, on the top of a jack pine in an extensive burn. Close inspection of the adults gave no reason for considering that they did not represent the race *B. j. borealis.* A flying juvenile male from this nest was collected. Its flags are conspicuously barred and the extent and tone of the brown back conforms with the race *borealis.* In this connection specimens in the museum's collection from this general region would indicate that an eastern race is to be expected here. Therefore, the details of the pair and brood of the other nest found are of special interest. The nest was situated 30 feet up in a jack pine, in a dense mixed woods bordering a large marsh. The adult male and two young females were collected. The adult male is almost entirely white ventrally, there being a few pale-brown, broken bars on the sides; the flags are unmarked and the tail beneath shows no pigmentation. Dorsally the bird is heavily blotched with white, on the wing coverts, tertials and

scapulars. The whitish tail is weakly tinged with pale reddish brown above, largely on the inner webs of the feathers, and the band near the tip is narrow and broken. The colour of the middle back is approximately "mummy brown" and the brownish colour of the head, neck and secondaries ranges from "hair brown" to "drab". The young birds collected, for which there is no reason to doubt they are the offspring of the male described above, are not in full plumage but they exhibit extensive areas of white and the flags are unmarked. Empirically these birds are *B. j. krideri*; geographically the locality is on the extreme edge of the known range of that form.
Specimens: 3 juvenals; 1 adult.

Buteo platypterus. BROAD-WINGED HAWK.—One of the more common hawks (*B. p. platypterus*) of the region though rendered somewhat more conspicuous than certain other species by its frequent vocal utterances and soaring habits. One or two almost daily at Ingolf; regularly and more plentifully (one to seven daily) at Wabigoon; rarely at Savanne. Noted on two occasions near Kenora in 1949 and considered regular and numerous there on a long term basis. Observed occasionally at Sioux Lookout and Malachi. An occupied nest was discovered but not examined at Wabigoon on June 17, 1937. It was situated 20 feet from the ground in a balsam poplar.
Specimen: 1 adult.

Buteo lagopus. ROUGH-LEGGED HAWK.—An individual, obviously a wanderer, was identified (Shortt and the writer) at Ingolf on June 7, 1937.

Haliaeetus leucocephalus. BALD EAGLE.—Available records pertaining to this species are few and may belie its numerical status. A nest was established on Gaherty Island, nine miles south of Kenora, on June 29, 1947. It contained at least one young which could be seen from the ground. In view of the early nesting of this species the records of birds seen in late May, 1949, probably concern locally-established birds: An adult seen near Allie Island on May 27 and again on May 31; one observed near Ferrier Island on May 28. A nest at Eagle Pass, Lake-of-the-Woods, was occupied "again" during the summer of 1949. The species is reported to have "nested in the trees of a small island between Felix and Cash Islands for many years and did so in 1949".

Circus cyaneus. MARSH HAWK.—This species (New World race, *C. c. hudsonius*) is widely distributed in the region, but not common: Ingolf, one noted in thirteen days afield; the Ontario portion of Indian Bay, fairly frequent; Kenora, occasional; Redditt, one seen; Wabigoon, one or two noted on four days out of twenty-one; Dinorwic Lake, noted; Savanne, one or two recorded on eight days out of twelve afield; Sioux Lookout, one noted on two days out of nineteen; Malachi, one or two noted on four days out of fourteen.
Specimen: 1 adult.

Pandion haliaetus. OSPREY.—Found to be widely but not regularly distributed in the region as a whole. A pair nested "for many years" on Harbour Island, north

of Minaki, until the nesting tree fell in the early 1940's. A pair became established on the mainland near this site in 1941. An occupied nest was observed 40 feet up in a live white pine on June 17, 1947, near Kenora and another, found near there on June 9, 1949, was situated on top of a steel electric tower. Other nests in the Kenora area are: One on Allie Island found June 19, 1947; one at Longbow Lake, about two miles east of Kenora, on July 30, 1949; one at Bishop's Point, seven miles southeast of Kenora, occupied for a number of years until 1950; and another on an unnamed lake seventeen miles east of Kenora in August, 1941. The species is resident in summer near Dryden and "at least six nests" were discovered along the drowned shores of Dinorwic Lake during early June, 1940. Observed at Minaki on August 15, and at White Dog Rapids on August 18, in 1937. At Malachi from one to four were recorded on six days out of fourteen in July, 1947, the record of four observed including a family group. The North American form is *P. h. carolinensis*.
Specimen: 1 adult.

Falco columbarius. PIGEON HAWK.—Occurs rarely and sporadically in summer. Has been observed at Kenora; one seen at Ingolf (June 9); one on two occasions at Wabigoon, June 14 and 18, 1937. Individuals were recorded on July 15, and July 17, 1947, at Malachi. A yearling male collected at Wabigoon is readily referable to the typical race *columbarius*. It is acquiring its first slaty-blue plumage, replacement being most advanced among the scapulars, interscapulars and upper breast feathers. The worn wings and tail are not involved in feather replacement.
Specimen: 1 sub-adult.

Falco sparverius. SPARROW HAWK.—Observed sparingly in the Ontario portion of Indian Bay during the summer of 1920. Individuals or pairs observed at Kenora and Redditt on four days out of ten in early June, 1949. Individuals recorded on two occasions at Wabigoon and on three occasions at Savanne in 1937. Reported as present at Dinorwic Lake in June, 1940. At Sioux Lookout it was observed regularly from June 23 to July 9, 1947, numbers ranging from one to four. Not quite as common at Malachi where from one to three were noted on seven days of the two weeks spent there. Specimens conform with *F. s. sparverius*.
Specimens: 3 adults.

Canachites canadensis. SPRUCE GROUSE.—A female collected at Ingolf on June 11 showed on dissection to be producing eggs, one in the oviduct having the shell completely formed and partly pigmented. At Savanne, young were secured on July 6 which were in an early transition stage from natal down to juvenal plumage. At the former place the spruce grouse was found in dry, rocky terrain with a sparse forest cover composed principally of jack pine and at Savanne it occurred in the humid black spruce swamp. Encountered on only one occasion at Sioux Lookout, a male on July 7, 1947, in a wet black spruce stand bordering a stream. Present but not plentiful in the Kenora region. Reported breeding at

Dinorwic Lake July 8, 1940, young being seen. It is obvious that this grouse has a sporadic distribution in the region as a whole.

Comparisons of the three mature female spruce grouse secured are of some interest. Two, known to be breeding birds, are typical of the race *canadensis*. The third is much more extensively tinged with rusty colour, ventrally and dorsally. Diligent observation of this individual before it was collected suggested that it was a non-breeding bird and subsequent dissection disclosed nothing to disturb this belief. The tail feathers of this specimen are somewhat narrow when compared with the two breeding females mentioned above (and other known breeding females in the Museum's collection). Those of breeding females are wider by approximately 6 mm., ½ inch from the tip, and are more blunt in terminal outline.

Specimens: 2 juvenals; 4 adults.

Bonasa umbellus. RUFFED GROUSE. — Listed by all contributors and for all the principal stations where observations were made, but variations in numbers are evident with respect to both place and period. The first brood of the year at Kenora in 1949 was June 9; at Ingolf in 1937, June 19. Definite breeding records based on young include the Dryden area, July 22, 1939; the Dinorwic area, early July, 1940; the Ontario portion of Indian Bay, during the summer of 1920; 15 miles east of Kenora, July 24, 1949; Sioux Lookout, July 1, 5 and 7, 1947; and Malachi, July 13, 14, 15, 18 and 31, 1947.

The ruffed grouse of this region is referred to *B. u. obscura* (*B. u. canescens* of Todd; Snyder and Shortt, 1946).

Specimens: 9 juvenals; 8 adults.

Pedioecetes phasianellus. SHARP-TAILED GROUSE. The species was reported by the local game overseer to be resident in an old burn near the airport five miles northeast of Kenora. Although inspection of this area, on June 8, 1949, failed to reveal birds, a maize of fresh tracks undoubtedly of this species was encountered. A young bird was observed at Redditt, August 3, 1952, and an autumn specimen from the Kenora area is in the Royal Ontario Museum of Zoology and Palaeontology collection.

In the light of Friedmann's study (1943) of this species, the available collection of sharp-tailed grouse has been re-examined by the writer. The conclusion drawn from this examination is that all specimens occupying the borders of the eastern forest and the grove belt of the Canadian prairie are *P. p. campestris*. The range of this form would therefore extend from the upper peninsula of Michigan through northern Wisconsin, Minnesota, western Ontario, northeastern North Dakota and the grove belt of southern Manitoba and Saskatchewan, to central Alberta and south in that province along the foothills. This conclusion does not entirely agree with Friedmann, with particular respect to the western extension of *campestris* and the curtailment of the northward range of *jamesi*. It does re-affirm the writer's conclusions of fourteen years ago, however, and the then published outline of ranges (Snyder, 1939) needs revision only to include the valid form *P. p. caurus* Friedmann and to restrict accordingly the range of *kennicotti*.

Rallus limicola. VIRGINIA RAIL.—Known to occur at two localities, Redditt (June 3, 1949) and Wabigoon (1937). It was observed at two separate situations at Wabigoon; in the cat-tail marshes bordering Wabigoon Lake and in the cat-tail segments of a vast wet flat or "beaver meadow" four miles to the north. At the "beaver meadow" a nest and six eggs were taken on June 30. The nest was made of marsh grasses and situated nine inches above water. The incubating bird was collected and proved to be the male. This constitutes the most northern breeding record of the species (nominate race) for the province.
Specimen: 1 adult.

Porzana carolina. SORA.—Observed at Ingolf on two occasions in June and regularly at Wabigoon in June and July, 1937, where from one to three were recorded daily. Evidence that a nest of this rail was destroyed by some predator (apparently a grackle) was noticed at Wabigoon. The species is a fairly common summer resident of the marshes in the Kenora region—at Redditt, at Kenora proper, and on Sultana and Thompson's Islands.

Coturnicops noveboracensis. YELLOW RAIL.—Heard calling, at dusk or at night, from the marsh near Wabigoon Lake on June 2 and 24, and on July 4, 1937.

Fulica americana. AMERICAN COOT.—An uncommon summer resident but regular in the Kenora area. Observed at Sultana Island, six miles southeast of Kenora, in mid-summer, 1930.

Charadrius vociferus. KILLDEER.—Common but somewhat irregularly distributed in the region. Summer occurrence and breeding records are as follows: Ingolf, two to five daily from June 1 to 13, 1937; Galt Island in Shoal Lake, nest with one egg on June 5, 1949 (previous clutch known to have been destroyed by crows); Kenora, nest and three eggs, June 7, 1930; Wabigoon, one to six daily from June 14 to July 4, 1937; Dryden, nest, June, 1939; Dinorwic Lake, observed regularly in Southworth and Hartman Townships, 1940; Malachi, young of the year, August 6, 1947. The North American form is *C. v. vociferus*.
Specimens: 1 juvenal; 1 adult.

Capella gallinago. COMMON SNIPE.—Occurs rarely in summer in the Kenora area. On July 5, 1937, an individual bird was observed at Upsala, Thunder Bay District, a few miles west of Savanne. The paucity of records for the region must rest largely on ecological grounds. It is known to be established in summer immediately to the south (Snyder, 1938) and to the east (Dear, 1940), and summer occurrence records for farther north are known.

Actitis macularia. SPOTTED SANDPIPER.—Occurrence records for this species concern places well distributed through the region. Noted on one of the islands in the Ontario portion of Indian Bay. Recorded from the Shoal Lake area and Allie Island in Lake-of-the-Woods. Observed in the Dryden portion of Wabigoon Lake. A few pairs were observed regularly (one to three daily) at Ingolf and also at

Wabigoon in 1937, and on one occasion at Savanne. Other summer occurrence records include Laval, Brownridge, Southworth and Hartman Townships in the Dinorwic Lake area, Minaki and White Dog Rapids. One to three, daily, were observed at Sioux Lookout. Breeding status proof was established for Ingolf (nests and three eggs, a completed clutch) June 5, 1937; Kenora, nest with four eggs, June 18, 1930 (Baillie and Harrington, 1936–37); and young observed on June 20, 1939, near Dryden and also on July 21, 1947, at Malachi.
Specimens: 3 adults.

Tringa solitaria. SOLITARY SANDPIPER.—Present in the Kenora region as a summer transient but not plentiful; specific observation concerns an individual observed there on July 31, 1931.

[*Catoptrophorus semipalmatus.* WILLET.—A willet was identified at Kenora in August, 1932, by Dr. Hugh C. Keenan, an observer associated with Mr. Leslie Paterson who was convinced of the correctness of the identification. It is included here as hypothetical. The willet is an established breeding bird in southern Manitoba (the western form, *inornatus*). Consequently, stragglers might be expected rarely in extreme western Ontario.]

Totanus melanoleucus. GREATER YELLOW-LEGS.—Not an uncommon transient which occurs during the summer months in the Kenora region. Observed in the Dryden area in August, 1939.

Totanus flavipes. LESSER YELLOW-LEGS.—Four specific records are available: An individual observed on August 8, 1943, at the Rushing River; "first autumn movement of the species" near Kenora July 31, 1948, and on August 1, 1949, near Kenora; observed on August 20, 1937, at Minaki.

Erolia minutilla. LEAST SANDPIPER.—Not uncommon as a summer transient in the Kenora area. Few observed in late summer, 1930, on Echlin's Island.

Ereunetes pusillus. SEMIPALMATED SANDPIPER.—Not uncommon as a summer transient in the Kenora area. Observed in early June, 1940, at Dinorwic Lake.

Lobipes lobatus. NORTHERN PHALAROPE.—A rare wanderer to the region. A specimen collected on August 8, 1932, near Kenora by Paterson, but not now available.

Larus argentatus. HERRING GULL.—A common summer bird of the region. Breeding colonies are established on some of the larger lakes, and scattered birds, presumably on food patrol, may be expected on most of the lakes and rivers. From one to 130, daily, on northern Lake-of-the-Woods, including Shoal Lake, in 1947 and 1949. Two colonies visited, both in late May, 1949, were associated with breeding cormorants. One on the northern corner of Cliff Island contained 35 nests; the other on Allie Island contained 21. Found breeding in the Dryden area on June 12 and 13, 1939. In 1937 and 1947, the species was observed as follows:

Ingolf, single birds occasionally; Wabigoon, few, occasional; Savanne, singles, occasionally; Sioux Lookout, one to ten, daily; Malachi, one to four daily. Included among the birds observed at both Minaki and White Dog Rapids in mid-August, 1937.

Larus delawarensis. RING-BILLED GULL.—Observed on August 16, 1937, at Minaki and also on August 19, 1943, near Kenora. The general continental breeding range of this species appears to be divided into eastern and western lobes, the gap occurring approximately in the Minnesota-western Ontario longitude. Summer occurrence records such as those here reported might be regarded as giving continuity to range but there is no evidence of a breeding status and even wanderers are rare.

Larus pipixcan. FRANKLIN'S GULL.—A flock of seven Franklin's gulls was seen by Messrs. Cartwright, Paterson, Shortt and the writer flying in a southerly direction on June 13, 1937, at Ingolf. Their characteristic wing pattern and unmistakable cries left no doubt as to their identity. All were in the black-headed adult plumage. Although this constitutes one of the few records for the province, it is in no sense widely extra-limital.

Sterna hirundo. COMMON TERN.—Common and breeds in the Kenora area. One colony, comprised of about 40 birds, was observed on a small rock island near Shoal Lake Narrows on June 16, 1947. A colony reported for the Dryden area of Wabigoon Lake had scrapes containing eggs and young when inspected on July 15, 1939. In 1940 a colony examined in Southworth Township contained 24 nests with a total of 70 eggs on June 17. Four wandering birds were observed at Ingolf on June 12, 1937.

Hydroprogne caspia. CASPIAN TERN.—A Caspian tern was observed on June 2 at Ingolf on Long Pine Lake; also two on June 3, and three on June 4, all in 1937. No additional records for the region are available to render these summer occurrences less remarkable. The nearest occurrences are those reported and cited by Snyder (1938).

Chlidonias niger. BLACK TERN.—A breeding species (*C. n. surinamensis*) in the Kenora area, two occupied nests being found there on June 16, 1947. Also breeding colonies were reported for Contact Bay on Wabigoon Lake and at Trap and Mile Lakes, all in the Dryden area. Additional scattered summer records are as follows: Wabigoon, four to fifteen daily, mid-June to early July, 1937; Oxdrift (five miles west of Dryden), one observed June 21, 1947; Malachi, one observed July 24, 1947.

The breeding distribution of this species in Ontario has few parallels. It includes the southern, western and northern margin of the province, but not the interior. Being a marsh dweller it is understandable that this tern would find suitable habitat in the deep-soiled, southern peninsula, and also along the flat, low coast of Hudson and James Bays. The fact that the species finds ecologically suit-

able niches on the pre-Cambrian rock of western Ontario suggests that it could also find suitable breeding stations here and there in the interior. Some other limiting factor, or factors, would seem to be involved.
Specimen: 1 adult.

Columba livia. ROCK DOVE OR DOMESTIC PIGEON.—This semi-domestic import is included in this list since it occurs as a feral breeding species around the town of Kenora, persisting there the year round.

[*Ectopistes migratorius*. PASSENGER PIGEON. Atkinson (1905) makes the statement that ". . . great numbers of them bred . . . through the district north of Lake-of-the-Woods and Rainy Lake". This clearly includes the area covered by this report, thus the insertion of this extinct species in this list.]

Zenaidura macroura. MOURNING DOVE. Occurs in the Kenora area rarely in summer. The two more-or-less detailed records available are largely circumstantial. During a visit to northern Lake-of-the-Woods during mid-June, 1947, Prof. J. R. Dymond heard the familiar call of the mourning dove on one occasion. During our stay at Wabigoon in 1937 residents described a dove seen earlier in the summer feeding along the railway east of the station. These reports are strengthened by additional distributional facts. Rare summer occurrence of the species has been substantially documented for western Rainy River region immediately to the south (Snyder, 1938) and for the region of Thunder Bay, Lake Superior (Dear, 1940). Furthermore, a specimen in the R.O.M.Z.P., an immature, was actually taken in the area here considered, but not in summer. It originated at Northpines, near Pelican Lake, eight miles west of Sioux Lookout and was taken October 15, 1930 (Baillie, 1931). Still another specimen in the R.O.M.Z.P. was taken by an Indian at "Swain's Lake, ninety miles north and west of Sioux Lookout" on May 11, 1934. This is beyond the borders of the area covered by the present report, but it indicates the northern wandering of the species beyond and presumably through this part of the province. The two specimens referred to, represent the race *Z. m. carolinensis*. However, a specimen from the Port Arthur region is intermediate, tending toward the western race *Z. m. marginella*. The general region is marginal for both forms.

Coccyzus erythropthalmus. BLACK-BILLED CUCKOO.—The occurrence of this species in this latitude is of considerable interest. Baillie and Harrington (1936-37) have recorded an occurrence on June 10, 1932. In 1937 one was observed at our most westerly camp, at Ingolf, on June 9. The daily record of species observed at our Wabigoon camp shows that one or two were recorded on nine of the twenty-one days spent there. Two were noted at Savanne, on July 7, one of which was collected. It proved to be a female and an egg was found in the oviduct.

There is slight evidence that this species was somewhat more numerous in the area between Ingolf and Savanne in 1937 than was usual. Local residents inquired about this bird which they had not been aware of previously. We had found it to be rare to the south, in western Rainy River District, in 1929 (Snyder, 1938). If there was a local peak of numbers, due to increase or influx during

1937, it could be correlated with a local outbreak of epidemic proportions of the forest tent caterpillar which took place in 1936 and 1937. It was reported to us that at times trains stopping at Wabigoon station had difficulty getting under way because of the slippery rails brought about by crawling larvae. However, the black-billed cuckoo occurred, rarely, still farther north, in 1947, a year during which there was no local forest tent caterpillar epidemic. Individual birds were noted at Sioux Lookout on July 5 and 6 and one was noted at Malachi on three occasions, July 17 and August 4 and 5. One was observed at Kenora on June 10, 1949.
Specimens: 4 adults.

Bubo virginianus. HORNED OWL.—The facts of occurrence relative to this species suggest its general distribution in the region in summer, probably with local and periodic variation in numbers. In 1937 the species was recorded on three occasions at Ingolf, twice at Wabigoon, almost nightly at Savanne where certainly three individuals were recorded on the night of July 6. In 1947 horned owls were recorded on five occasions at Sioux Lookout and three were noted at Malachi. The species is usually fairly common in the vicinity of Kenora.

Four specimens representing the population established in the region in summer were secured. Examination of this material, though highly interesting, provides no conclusive points with respect to racial representation. The most positive statement that can be made is that the typical race *virginianus* is not represented. The four specimens depict three rather distinct variations. The specimens from Ingolf and Wabigoon may be referred to *wapacuthu* with reservation, that is, they are not as extensively white as representatives of that race from farther west, in Manitoba. The specimen from Malachi is so extensively dusky as to be quite unlike *wapacuthu* and the Malachi specimen is wholly dissimilar paralleling the dark races of the Pacific and Labrador regions. A local study such as this can contribute little with respect to variation of this species beyond calling attention to heterogeneous variation and remarking that the case is not without parallel among birds of the region. Three of the specimens collected were examined by Taverner (1942) during his study of the "Canadian Races of the Great Horned Owls".
Specimens: 4 adults.

Strix varia. BARRED OWL.—Occurrence of this species as a rare bird of the area with which we are concerned has long been a matter of record ("Rat Portage" = Kenora; Thompson, 1890). The specimen collected (*S. v. varia*) is one of the few extant from the extreme northern part of its range in Ontario. It was taken at Ingolf on June 11, 1937. Reported for the Dinorwic Lake region during early July, 1940.
Specimen: 1 adult.

Aegolius acadicus. SAW-WHET OWL.—The only positive record of this species concerns a female (*A. a. acadicus*) which had been killed on the highway eight miles west of Kenora and picked up in fresh condition on June 23, 1951. When

dissected the ovaries were found to be enlarged and certain follicles appeared to be in a post-rupture condition.

There was some suspicion that *A. funereus* (the North American race, *A. f. richardsoni*) might also occur in this region. On the night of June 14-15, 1937, the unfamiliar yet unmistakable voice of an owl was heard at Wabigoon, coming from a clump of evergreens. The sound was repeated several times, a slow, somewhat ascending series of liquid "took" sounds like the dripping of water into a partially-filled vessel. Authors state for *A. funereus*, utters "a low liquid note that resembles the sound produced by water dripping from a height"; and "a liquid note like dripping water". However, there is some evidence that *A. acadicus* may produce a similar sound.
Specimen: 1 adult.

Chordeiles minor. NIGHTHAWK. - Well-distributed throughout the region. Plentiful in the rock country around Ingolf (largest daily total, nine, in 1937) and at Malachi (averaging more than five daily with twelve noted on July 14, 1947). On the evening of July 13 at the latter place a number of nighthawks were observed feeding on or near the ground. The situation was an open, sandy ridge along the railroad. A specimen collected had a grasshopper in its gullet. Whether these insects were actually being picked up from the ground, or flushed, then caught, could not be perceived, but the birds were making short low flights and settling at intervals. The species is a regular and fairly common summer resident of the Kenora region, and was observed at Minaki, Wabigoon, the Dinorwic Lake region, Savanne and Sioux Lookout. A female taken at Ingolf on June 8 had a shell-covered, pigmented egg in the oviduct and a second large egg without a shell was ready to pass down the oviduct. Breeding status was established in the Dryden area (a clutch of two eggs found on July 3 and two young observed on July 20, 1939); and in Southworth Township near Dinorwic (two eggs, June 21, 1940). A migratory or pre-migratory congregation estimated to be comprised of 200 individuals was observed at 7.30 p.m. on August 4, 1947, at Malachi. Southward movement has been noticed in the Kenora area as early as July 26 (in 1951) though the first week of August is more usual.

Examination of the specimens collected does not show that birds of this region tend toward southwestern races. After rather extensive comparisons it has become obvious that a general review of Canadian nighthawks is needed. Preliminary work on this matter suggests the possibility that the evergreen forest population across the north may be distinct from the nominate race of the southeast. Such would admittedly produce a puzzling situation inasmuch as most nighthawk specimens from southern British Columbia seem remarkably similar to those from Nova Scotia.
Specimens: 1 juvenal; 6 adults.

Chaetura pelagica. CHIMNEY SWIFT.--Absent or rare throughout most wilderness areas but found sparingly, or fairly commonly, about most settlements. Fairly common in the Kenora area; occasional at Wabigoon (six, the largest daily

total, on June 23); and daily at Savanne (two to six). One observed near Redditt on June 3, 1949. Definite breeding status was established for the species at Savanne, the female collected there having a fully-developed egg in the oviduct.
Specimen: 1 adult.

Archilochus colubris. RUBY-THROATED HUMMINGBIRD.—Observed regularly at Indian Bay and Ingolf; occasionally at Kenora, Echlin's Island, northern Shoal Lake and Minaki; rarely at Wabigoon and Sioux Lookout; and rather commonly at Malachi (one to five daily). Occurrence was reported for Upsala. A nest containing two eggs was found twenty feet from the ground in a paper birch at Wabigoon on June 19, 1937 (Baillie and Harrington, 1936–37).
Specimens: 1 juvenal; 1 adult.

Megaceryle alcyon. BELTED KINGFISHER.—One to four observed daily at Ingolf, Kenora, northern Shoal Lake, Wabigoon, Sioux Lookout and Malachi; rarely at Savanne. Occurrences were reported from Echlin's Island, the Dinorwic Lake area, Dryden and Minaki. Although it is probable that this species breeds here and there throughout the region, it so happens that only one definite breeding record is available from the many contributing sources. A nest-tunnel was found on a river bank near Kenora on June 20, 1930. The race of the region is *M. a. alcyon*.

Colaptes auratus. YELLOW-SHAFTED FLICKER.—Recorded from Indian Bay, northern Shoal Lake, Echlin's Island, Kenora, Ingolf, Wabigoon, the Dinorwic Lake area, Sioux Lookout, Minaki and Malachi. Frequency data indicate that the species is moderately plentiful throughout the region. The flicker was recorded daily at all principal collecting stations and from five to ten were not exceptional. Evidence of breeding was secured for Ingolf, Kenora, Wabigoon, Sioux Lookout, Malachi, and Southworth Township in the Dinorwic Lake area. As a matter of record, a male collected on June 19, 1937, at Wabigoon possessed a bare brooding patch on the belly.

The minimum, maximum and average measurements of six adult males collected are as follows: Length, 302–323 (308.5); chord of wing, 156–161 (159.5); tail, 98–110 (104.5); chord of culmen from skin at base, 34–39 (35.5); average wing spread of two, 513.5; average weight of two, 138.5 gms. The following measurements are for the five adult females: Length, 293–311 (304); chord of wing, 150–159 (154); tail, 89–102 (94.8); chord of culmen from skin at base, 31–37 (34.2); average wing spread of four, 495.8; average weight of two, 134 gms. As Rand (1944) has pointed out, this species exhibits variations as a cline. He does not mention that there is a slight sexual difference in size, as is indicated by the above measurements. However, he gives minimum and maximum wing measurements for the species, apparently of males and direct from Ridgway (1914). The range in wing length is from 144 to 170, a variation of 26 within the species. Segmenting a cline into three sections is arbitrary and a matter of arithmetic, and "races" so established seemingly should be so indicated.

In recognizing three segments of the flicker species, the wing-length range for males for each would be, logically, as follows: *C. a. auratus*, 144 to 152; *C. a. luteus*, 152 to 161; and *C. a. borealis*, 161 to 170. Concerning the specimens collected between latitude 49° and 50° in western Ontario, the wing length of each falls within the middle third of size range and therefore they are arbitrarily named *C. a. luteus* cline.
Specimens: 3 juvenals; 11 adults.

Dryocopus pileatus. PILEATED WOODPECKER.—Observed rarely or occasionally in the Indian Bay and High Lake region, at Ingolf, Kenora, Allie Island, Dryden and at Dinorwic Lake; somewhat more regularly (one or two nearly every day) at Savanne, Sioux Lookout and Malachi. Baillie and Harrington (1936–37) have recorded the breeding of this species in the Indian Bay region to which Malchi can be added.
Specimens: 2 juvenals.

Melanerpes erythrocephalus. RED-HEADED WOODPECKER. A rare summer resident in the Kenora region; pairs noted at Malachi. These are the most northerly records for the province.

In considering the probable racial representation of this species in western Ontario, the measurements of five specimens from western Rainy River District were included in the following: Males (three specimens) length 232–242 (238.3); chord of wing (four specimens) 141–145 (142.5); tail (four specimens) 75–80 (77.5); chord of culmen from skin at base, 27.5–29.5 (28.4); weight (four specimens) 68.6–81 (75.5 gms.). Females (three specimens) length, 219–234 (228); chord of wing 135–141 (137.4); tail (two specimens) 75–80 (77.5); chord of culmen from skin at base, 25–26 (25.4); weight 71–77.75 (74.4 gms.). Except for the culmen measurements, which may have been taken differently from those presented by Brodkorb (1935) these specimens tend toward the western race. The yellowish colour of the underparts displayed by the series is also characteristic of *M. e. caurinus*.
Specimens: 2 adults.

Sphyrapicus varius. YELLOW-BELLIED SAPSUCKER. Occurrences were reported from throughout the region but there is considerable local variation in numbers, probably associated with forest types. Baillie and Harrington (1936–37) have recorded the species as breeding abundantly in 1920 on the Ontario side of Indian Bay. From one to fifteen observed daily at Malachi where breeding status was established. A common breeding bird of the Kenora area. Other stations showed a sparse population: Observed but twice at Ingolf in two weeks; twice at Wabigoon (breeds) in three weeks; and five times at Sioux Lookout in nearly three weeks; rarely, in Southworth Township only, in the Dinorwic Lake region. Observed in August at Minaki. Specimens are characteristic of the nominate race.
Specimens: 2 juvenals; 5 adults.

Dendrocopos villosus. HAIRY WOODPECKER.—Reported from throughout the region with local variation in numbers. Baillie and Harrington (1936–37) have

recorded it as fairly plentiful and breeding in the Indian Bay area. Other records are as follows: Observed in northern Shoal Lake on June 5, 1949; fairly plentiful and breeds at Kenora; observed at Dryden in 1939 and in Southworth and Hartman Townships in the Dinorwic Lake area in 1940; one to seven recorded daily at Ingolf in 1937 (one nest with young found seven feet from the ground in a poplar on June 3 and another nine feet up in a poplar on June 11, 1937); recorded occasionally at Wabigoon where flying young were observed on June 29; one or two recorded regularly at Sioux Lookout in June and July, 1947; one to five, fairly regularly, at Malachi; and observed at White Dog Rapids on August 18, 1937.

Rand (1948a) has recently dealt with the boundaries between *D. v. villosus* and *D. v. septentrionalis* in Canada. He does not mention that there is slight sexual variation in this species or that size variation, from southeastern continental North America, north and northwestward, occurs as a cline. Ridgway (1914) gives the minimum wing measurement for males of the smallest component (southeast) as 110.5 and the maximum for the largest (far north) as 138, an overall spread of 27.5. Designating three cline divisions within this range of wing length is again (see under flicker above) purely arbitrary and arithmetical. Logically the wing length of each arbitrary division would have a range of approximately nine millimetres, or seven to eight percent increase in size. Accordingly we should set the range of wing-length of males for each division of this cline approximately as follows: *D. v. audubonii*, 110.5–119; *D. v. villosus*, 119-128; *D. v. septentrionalis*, 128–138.

The four adult males and five adult females collected measure as follows: Males -- length (three specimens only) 248–262 (255.7); chord of wing, 127–132 (129.8); tail (three specimens) 78–85 (83.1); chord of culmen (from skin at base) 35.5 39 (36.7); wing spread (three specimens) 406–412 (409.4); weight (one specimen) 84 gms. Females—length (two specimens) 243-248 (245.5); chord of wing 125-132 (127.6); tail (two specimens) 80–84 (82); chord of culmen (four specimens) 31--33.5 (32); wing spread (three specimens) 400–415 (407); weight (three specimens) 72–76.5 (74.5) gms.

Applying the arbitrary limits as set out above, the population of the species in this portion of western Ontario averages with the larger of the three components of this cline species. They would therefore be referred to *D. v. septentrionalis* cline, if a trinomial is applied to such divisions.

Specimens: 2 juvenals; 9 adults.

Dendrocopos pubescens. DOWNY WOODPECKER.—Though widely distributed the species is for the most part rare, even absent locally. An exception is the report of Baillie and Harrington (1936–37) who state that it nested abundantly in the Ontario portion of Indian Bay in 1920. Long-term observations at Kenora indicate that it is only moderately common there. Few were observed at Ingolf, one on June 21 and two on June 25. Only one was recorded at Sioux Lookout, on June 26, 1947. At Malachi the species was met with fairly regularly and found breeding but the population was sparse. Observed occasionally in both South-

worth and Hartman Townships of the Dinorwic Lake area in 1940 and reported present at Minaki on August 14, 1937. Field experience in the forests of this region gives no clue as to why the population of the downy woodpecker, with rare exception, is sparse. It is doubted that there is any correlation between the abundance reports and the several year periods represented.

Here again we are dealing with a species which exhibits size variation as a cline in the same way as does the hairy woodpecker. The minimum wing-length of males, of the species as a whole, given by Ridgway (1914) is 86 and the maximum is 101.5. Variation in this measurement from Florida and the Gulf Coast to James Bay and Alaska, is therefore 15.5. If an arbitrary division into three size components is made, then the line between them should be drawn at approximately 5 millimetre intervals. On this basis the arbitrary size-segments for males, together with current names applied to them, are as follows: *D. p. pubescens*, 86-91; *D. p. medianus*, 91-96; *D. p. nelsoni*, 96-101.5. Measurements of the three adult males collected are as follows: Length, 157-168 (163.7); chord of wing, 93-96 (94.7); tail, 55-57 (56); chord of culmen from skin at base, 19-20.3 (19.5); average wingspread of two, 300; average weight of two, 26.8 gms. The downy woodpecker population of western Ontario clearly falls within the middle third of the range of wingsize for the species and, if recognized by nomenclature, would be named *D. p. medianus* cline.

Specimens: 3 juvenals; 3 adults.

Picoides arcticus. ARCTIC THREE-TOED WOODPECKER.—This species is rather evenly distributed throughout the region but there are variations in its numbers in accord with local ecological conditions. For example, none was observed in the "old, mixed forest" in the vicinity of Sioux Lookout during the eighteen days stay there in 1947 but at Malachi where there was an extensive, recently burned-over area, this woodpecker was an established breeding species recorded regularly and in plentiful numbers, a total of fifty being noted on July 24. Baillie and Harrington (1936-37) record the Arctic three-toed woodpecker as breeding at High Lake in 1920. It is a fairly common breeding bird of the Kenora area. It was found established as a breeding species at Ingolf (nest with young twenty feet up in live jack pine, on June 11) and Wabigoon (nest with young eighteen feet up in aspen, on June 16) in 1937 but in restricted numbers. Observed rarely at Savanne in 1937 and occasionally in 1940 in Southworth and Hartman Townships of the Dinorwic Lake area.

Specimens: 3 juvenals; 4 adults.

Picoides tridactylus. COMMON THREE-TOED WOODPECKER.—The distribution of this species (*P. t. bacatus*) is rather sporadic. It is present in the Kenora area in summer but not common. One was observed at Wabigoon on June 29, 1937 and a few were recorded on four days out of thirteen at Savanne (nine on July 14) where its breeding status was determined (nest with young found twenty-five feet up in a black spruce on July 14). On July 10 two three-toed woodpeckers in close association were flushed from near the ground in a stand of young black

spruce. Both were collected. One proved to be an adult female of this species and the other was a juvenile of *P. arcticus*. Further observation at the time showed that adults of both species, together with their families, were intermingling at this place while feeding. At Malachi in July, 1947, the species was observed on two occasions, including young of the year.
Specimens: 3 juvenals; 5 adults.

Tyrannus tyrannus. EASTERN KINGBIRD.—Found throughout the region, most commonly (two to fifteen daily) at Malachi, Kenora and Wabigoon, and least so at Savanne. Two specific breeding records were established: An occupied nest twelve feet up in a jack pine at Wabigoon on June 20, 1937, and a nest containing three well-developed young nine feet up in a black spruce at Malachi on July 20, 1947. It has been found breeding at Kenora. It seems apparent that deforestation and forest fires have favoured the increase of this species in the region.
Specimens: 5 adults.

Tyrannus verticalis. WESTERN KINGBIRD.—This species has been extending its range eastward in recent years and proof of its entry into Ontario now exists in the form of the specimen collected on June 4, 1937, at Ingolf. This is the first specimen to be collected in the province, although there are several sight records for southern counties and a nest with three eggs was found near Port Alma, Kent County, on June 26, 1943.
Specimen: 1 adult.

Myiarchus crinitus. CRESTED FLYCATCHER.—One was observed at Ingolf on June 4 and 5, 1937; another at Shoal Lake Narrows during the summer of 1939 and again at the same place on June 17, 1947. A fourth record concerns one observed at Miles Bay during the summer of 1948.

Sayornis phoebe. EASTERN PHOEBE.—Our records show this species to be of regular occurrence at all stations where collections and observations were made and at most places our daily totals of individuals observed range from two to ten. Definite breeding evidence is available for Wabigoon, Savanne, Shoal Lake, Black Sturgeon River, Indian Bay and Chadwick Lake. Most nests found were placed on some man-made structure, usually the inside of a deserted building. One nest was situated on a rock cliff, at Chadwick Lake on August 5, 1949. Rowan (1922a) has reported nests in the Indian Bay area situated on the fallen trunks of trees. A female, the mate of which was collected on June 8, 1937, at Ingolf, had secured a new mate within twenty-four hours.
Specimens: 2 juvenals; 10 adults.

Empidonax flaviventris. YELLOW-BELLIED FLYCATCHER.—Uncommon but rather regularly distributed, having been observed at Malachi, Sioux Lookout, Ingolf, Kenora, Wabigoon and Savanne. A nest containing four slightly incubated eggs

was found in a hummock of deep moss in a rather dark, black spruce stand near Wabigoon on July 1, 1937.
Specimens: 2 juvenals; 3 adults.

Empidonax traillii. TRAILL'S FLYCATCHER.—Generally distributed but locally restricted to burns and clearings with young aspen poplar stands from five to ten feet high, and to alder-willow thickets in swales and shore areas.

Examination of the specimens collected show them all to be very alike with respect to the olive colour of the dorsal area which is characteristic of specimens from across Canada to the mountains, *E. t. alnorum* Brewster.
Specimens: 4 adults.

Empidonax minimus. LEAST FLYCATCHER.—The most common flycatcher of the region. It occupied the older aspen poplar stands and paper birch copses where edge conditions prevailed. Summer occurrence records are included on all lists received from observers, from Indian Bay east to the Dinorwic area and north to Minaki. Listed daily at all collecting stations with frequent totals of from ten to twenty individuals. Although the species is commonly observed to be conspicuously defensive of its territory, two nests with eggs, found at Kenora on June 12, 1930, were approximately only thirty feet apart.
Specimens: 1 juvenal; 6 adults.

Contopus virens. EASTERN WOOD PEWEE.—Records of occurrence include the region from Indian Bay, Shoal Lake and Kenora, north to Minaki, Malachi and Sioux Lookout, but only a single occurrence was noted at the latter place (on July 5, 1947). It was regular and not rare at Ingolf and Malachi, noted occasionally at Wabigoon, and rare in the Dryden area and in Hartman Township in the Dinorwic area.
Specimens: 10 adults.

Nuttallornis borealis. OLIVE-SIDED FLYCATCHER. Nowhere common though it occurs regularly throughout the spruce country of the region. Specifically recorded from northern Shoal Lake, Kenora, Ingolf (one to four daily), Malachi (one to seven daily with twenty on July 24), Wabigoon (one to four daily), rarely at Sioux Lookout, and regularly at Savanne (one to six daily).
Specimens: 4 adults.

[*Eremophila alpestris.* HORNED LARK.—Reported in error (see Oberholser, 1902) as a breeding bird of Kenora (= Rat Portage) by Macoun and Macoun (1909) and repeated by Baillie and Harrington (1936-37). No summer occurrences are known. Actually one might expect the species in summer in the relatively new farmland such as is found in the Dryden area. The form most likely to occur would be *E. a. enthymia* (see Snyder, 1938). A point of interest seems to be that the three (possibly four) geographic races which occur in Ontario are distinctly isolated one from another in summer.]

Irodoprocne bicolor. TREE SWALLOW.—A common breeding species at Indian Bay, Shoal Lake Narrows, Allie Island, Ingolf, Kenora, Wabigoon, Savanne,

Dinorwic Lake, Malachi and Sioux Lookout, occupying wooded shores, burns and partial clearings. At Kenora bird-boxes attract this species for nesting within the town. A congregation of approximately four hundred was observed at Dryden on July 22, 1939.
Specimens: 2 juvenals; 1 adult.

Riparia riparia. BANK SWALLOW.—A relatively scarce swallow (*R. r. riparia*) for the region as a whole. A few noted at Kenora on June 8, 9 and 10, and four at Redditt on the latter date, 1949. From two to four recorded on four days out of fourteen at Malachi in mid-July, 1947. Baillie and Harrington (1936–37) have recorded breeding for Kenora. Breeds at Malachi.
Specimen: 1 juvenal.

Hirundo rustica. BARN SWALLOW.—Widely distributed through the region but notably restricted to settlements. Details pertaining to occurrence are as follows: Few observed at Shoal Lake Narrows; fairly common and breeding at Kenora; three to ten observed daily at Ingolf where it was found nesting in buildings; adults and young observed at Upsala; observed in small numbers at Wabigoon, a nest being found in an old barn; a few observed in Southworth Township in the Dinorwic area; common at Malachi where it bred; and scarce at Sioux Lookout. All evidence indicates that the species (race, *H. r. erythrogaster*) is now virtually dependent on man-made structures for nesting.
Specimens: 3 adults.

Petrochelidon pyrrhonota. CLIFF SWALLOW.—Sporadically distributed. Summer occurrence was noted at Malachi and Eagle River. Known to nest at Vermilion (colony of about ten); at Black Sturgeon River between Kenora and Redditt where a colony of about forty was observed building nests under the eave of a frame house on June 1, 1949; at Redditt (building nests in gable on rear of railroad station, June 3, 1949); and at Wabigoon (colony, on June 10, 1952). Race, *P. p. pyrrhonota.*
Specimen: 1 adult.

Progne subis. PURPLE MARTIN.—The northern form of this species, *P. s. subis*, has a sparse population within the region. Baillie and Harrington (1936–37) have recorded a four-family colony at Kenora, and noted nesting in architectural nooks in the bus station of that town. A breeding colony, consisting of approximately six pairs, was established in the railway water tank at Ingolf in 1937. Sparsely represented at Wabigoon and at Malachi. Lone pairs breeding on Blatzfiller's Island south of Kenora, on Galt Island, Lake-of-the-Woods on June 16, and three females on Allie Island on June 19, all in 1947. The most northerly breeding record for the region concerns a pair nesting in a bird box at Minaki during the summer of 1938.
Specimen: 1 adult.

Perisoreus canadensis. CANADA JAY.—Generally distributed. The highest daily total for any collecting station was twenty at Savanne on July 8, 1937. A nest

with four young found in April in the Wabigoon area has been reported by Baillie and Harrington (1936–37). Breeding records based on flying young are from Ingolf and Savanne. Young still being fed by adults observed on June 18, 1937. The nominate race occupies this region.
Specimens: 4 juvenals; 10 adults.

Cyanocitta cristata. BLUE JAY.—Common at Minaki, Malachi, Ingolf, Kenora and Wabigoon; observed occasionally at Sioux Lookout, Sultana Island, Dinorwic Lake and Laval and Brownridge Townships of that area. The only definite breeding record is for Kenora (Baillie and Harrington, 1936–37). Specimens are characteristic of the northern race, *C. c. bromia.*
Specimens: 1 juvenal; 8 adults.

[*Pica pica.* BLACK-BILLED MAGPIE.—Though occurrence of wanderers is most likely during the non-breeding season, one of these strikingly marked birds was observed by Professor J. R. Dymond in the Kenora area during June, 1947 and the principal facts were communicated to the writer.]

Corvus corax. RAVEN.—The raven has increased in the Kenora area during the past twenty years. In 1930 it was rare in the environs of Kenora even in winter. In 1942 a pair wintered within the town limits and in 1944 two pairs were observed. By 1949 ravens were reported in unprecedented numbers at Storm Bay during late summer and early autumn. Breeding records are as follows: Two nests, "close together," 25 feet up on a ledge, at Gordon Lake in 1936; young observed at Minaki on July 20, 1938; a nest on a cliff at Willard Lake on June 9, 1941; in July, 1941, in the Ignace region, a nest twenty-five feet up in a balsam; young observed at Sioux Lookout in 1947. Baillie and Harrington (1936–37) record a nest found on a cliff at "Big Pine" Lake (= Wonderland Lake). Summer observations of the species include White Dog Rapids (August 18, 1937); Wabigoon (June 23, 1937); from one to five observed daily at both Malachi and Sioux Lookout in 1947, and Longbow Lake (1949). Race, *C. c. principalis.*
Specimens: 1 juvenal; 1 adult.

Corvus brachyrhynchos. CROW.—Observed daily at all collecting stations and camps, the highest daily total being at Wabigoon (22 on June 16, 1937). Definite breeding was established for Ingolf (nest, with four young, twenty feet up in a jack pine, June 3, 1937); Savanne (flying young, still being fed, July 12, 1937); and similar evidence from Malachi and Sioux Lookout in 1947. Common and breeding at Kenora and in the Ontario portion of Indian Bay. Measurements of adults collected are as follows: Four ♂♂, length 465 to 491 (av. 475.2); chord of wing 316 to 319 (av. 317), tail 181 to 187 (av. 184.5), culmen (chord, from base) 48 to 53 (av. 49.5); three ♀♀, length 437 to 464 (av. 450.3), chord of wing 291.5 to 300 (av. 295.6), tail 162 to 171 (av. 167.7), chord of culmen 45.5 to 49 (av. 47.2). These agree with the nominate race. A field note of interest pertaining to crows concerns their food-finding perception. Carcasses of

specimens buried in shallow holes near our camp at Ingolf were well covered and the earth tramped down. Nevertheless crows successfully prospected in these spots, returning daily to exhume the meat.
Specimens: 2 juvenals; 7 adults.

Parus atricapillus. BLACK-CAPPED CHICKADEE.—A fairly common breeding bird of the region, from one to seven observed daily at all collecting stations during June, with the daily count rising by the end of June when flying young appeared. Breeding status was established for Wabigoon (family, June 28, 1937), Savanne (family, July 9, 1937), Malachi (July 13 and 19, 1947) and Kenora. Baillie and Harrington (1936–37) record the species as breeding at Indian Bay. Summer occurrence records available concern White Dog Rapids, Minaki, Dinorwic Lake and Dryden.

In view of the fact that worn plumages can reveal very little with respect to racial affinities, discussion of this matter rests largely on winter specimens in the R.O.M.Z.P. Three more or less distinctive populations have an influence on the black-capped chickadees of western Ontario—*P. a. septentrionalis* from the west and southwest, *P. a. anamesus* from the north and east, and *P. a. atricapillus* from the south and east.

Specimens from the more northerly parts of Ontario agree in colour with great plains chickadees (*P. a. septentrionalis*), but are smaller, corresponding to specimens from southern Ontario (*P. a. atricapillus*) in size. The amount of white bordering the tail and flight feathers is intermediate between those races. Thus the northern population is precisely as described by Todd (1938), "a slightly differentiated race, intermediate between *atricapillus* and *septentrionalis*". Rand (1948b) has discouraged the recognition of *anamesus*-like birds since "they are apparently restricted to a small area in northern Ontario" and remarks, "to recognize every such area of intergradation would necessitate many other names and is impracticable". In the present case the area cannot be regarded as restricted. These slightly paler black-capped chickadees range completely across northern Ontario, which extends for more than five hundred miles, and the original describer gave an equally extensive range in Quebec. It is a matter of interest to note that the area occupied is not geographically intermediate between the ranges of the nominate race and *P. a. septentrionalis.* Since differentiation is admittedly slight, this population may not deserve nomenclatural recognition, but since certain details parallel other cases (chipping sparrow, ruffed grouse) these minor facts should not be obscured. The population named *P. a. anamesus* merges with *P. a. septentrionalis* in northwestern Ontario, north of the area here considered, and about on the Ontario-Manitoba line. The range of the latter race extends north in the prairie provinces at least to central Manitoba and central Saskatchewan, a conclusion somewhat contrary to that of Duvall (1945). The nominate race meets with the *P. a. anamesus* population west of Lake Superior, in the region here considered. The possibility of determining a precise intergrading belt between these two populations in Ontario seems remote. This statement rests on the difficulty of obtaining adequate winter specimens, on the slight

degree of difference, and the further complication resulting from the probability that northern populations move south in the autumn, at least during some years.

It is not inappropriate here to give some confirmation to the belief that northern birds will migrate considerable distances. In the autumn of 1951 there was a large flight of chickadees in southern Ontario, made most conspicuous by the presence of the boreal chickadee, *P. hudsonicus*, but certainly including a host of *P. atricapillus*. Information received at the Museum from Mrs. Louise Lawrence of Rutherglen in the northern part of southern Ontario concerned the flight of *P. atricapillus* at that locality. Pertaining to events at her banding station, she states that unbanded transients began to arrive during the first week of September, 1951. By the 27th these had all passed through the area, those remaining, about thirty individuals, being local birds which she had banded and which remained for the winter. Apparently the transients were northern birds which passed over the local and wintering population. When the flight was at its peak and had reached southern counties in late October, a series of specimens was secured from Toronto and Hamilton. Several are referable to *P. a. anamesus*, being slightly paler in colour than southern Ontario specimens, but like them in size. This evidence indicates that northern chickadees will migrate at least two hundred miles south or southwest in eastern parts of the province in autumn.

Measurements of adult, summer specimens secured are as follows: Chord of wing, eight ♂♂, 61.5 to 66 (av. 64.6); tail, 58.5 to 64 (av. 62.2). Chord of wing, three ♀♀, 61 to 64 (av. 62.5); tail (two specimens) each 59.
Specimens: 5 juvenals; 11 adults.

Parus hudsonicus. BOREAL CHICKADEE. Observed rarely at Minaki and at Wabigoon in 1937, and one seen at Sioux Lookout in 1947. Found most plentifully at Savanne (in 1937) where from six to fifteen were observed almost daily and at Malachi (in 1947). Breeding evidence was secured at Savanne. Summer occurrences were reported for the Kenora area. The race of the region is *P. h. hudsonicus* (see Godfrey, 1951).
Specimens: 1 juvenal; 3 adults.

Sitta canadensis. RED-BREASTED NUTHATCH.—Found throughout the region but not commonly. The record of Macoun and Macoun (1909) concerning a set of six eggs taken at Rat Portage (= Kenora) is the only definite breeding evidence available. Occasional summer occurrence reports concern Minaki, Malachi, Ingolf, Wabigoon and Dinorwic. Frequent summer occurrences (one to six daily) were recorded for Sioux Lookout.
Specimens: 1 juvenal; 1 adult.

Certhia familiaris. BROWN CREEPER.—Not plentiful but generally distributed. From one to eight observed on about half the days afield at Sioux Lookout and Malachi. Young of the year were procured at both these stations. Rather rare at Wabigoon where a recently emerged family of young was noted on July 1, 1937. Occasional summer occurrence records pertain to Minaki, Dryden, Kenora, Shebandowan Lake and Savanne. Race, *C. f. americana*.
Specimens: 2 juvenals; 4 adults.

Troglodytes aedon. HOUSE WREN.—Unevenly distributed through the region; most common about settlements. The largest daily total was recorded at Malachi where a total of fifty, adults and young, was recorded on July 24, 1947. Moderate numbers were recorded for Ingolf (breeding), Dryden, Wabigoon, and Kenora (breeding). Less common at Sioux Lookout, Dinorwic, Shoal Lake (breeding) and Indian Bay. The house wren of this region belongs with the race *T. a. parkmanii.* It is of interest to note that specimens in juvenal plumage display a paleness of the dorsal area and along the sides and flanks when compared with juvenals of related races and are therefore useful taxonomically.
Specimens: 2 juvenals; 19 adults.

Troglodytes troglodytes. WINTER WREN.—Sparsely and sporadically distributed in accord with its rather precise ecological requirements. Noted with the greatest regularity at Sioux Lookout where from one to four were recorded on half the days spent there, June 21 to July 8. It is rare at Malachi, Wabigoon, Savanne, and Kenora. Specimens agree with the eastern form, *T. t. hiemalis.*
Specimens: 8 adults.

Telmatodytes palustris. MARSH WREN.—Recorded from only three stations in the region. Reported as plentiful in the Ontario portion of Indian Bay in 1920. A pair was found established in a marsh near Wabigoon in 1937. A superfluous nest was found here also, which, it would seem, constitutes circumstantial breeding evidence. Individuals were noted on two days, July 11 and July 14, at Malachi, in 1947. The specimen secured is characteristic of the race *T. p. dissaeptus.*
Specimen: 1 adult.

Cistothorus platensis. SEDGE WREN.—This wren (*C. p. stellaris*) is much more generally distributed than *T. palustris.* Recorded on two occasions at Malachi in 1947; a small colony (three singing males) near Wabigoon and two observed at Savanne in 1937. The species was more common in the Kenora area. Singing males observed in three situations between Kenora and Redditt in June, 1949, colonies consisting of probably five or six pairs. Not uncommon in summer in the Ontario portion of Indian Bay.
Specimens: 5 adults.

Dumetella carolinensis. CATBIRD.—Found breeding in the Kenora area (Baillie and Harrington, 1936–37) and observed there rarely in 1947 and 1949; and at Shoal Lake in 1947. Also a rare inhabitant of the Malachi area in 1947. The specimen collected, like two from western Rainy River, is paler ventrally than is usual for southern Ontario specimens.
Specimen: 1 adult.

Toxostoma rufum. BROWN THRASHER.—Observed rarely at Kenora in summer (Paterson). Has been found breeding immediately to the south (Snyder, 1938).
Turdus migratorius. ROBIN.—Common and widely-distributed, most numerous about settlements. Breeding evidence is available for Malachi, Sioux Lookout,

Ingolf, Dryden, Wabigoon, Savanne, Shebandowan Lake, Shoal Lake and Kenora, and occurrence records add White Dog Rapids, Minaki, Redditt, Dinorwic, Allie Island and Indian Bay to its summer range. Specimens secured are characteristic of *T. m. migratorius.*
Specimens: 2 juvenals; 7 adults.

Hylocichla guttata. HERMIT THRUSH.—The numerical ratio of the *Hylocichla* thrushes varies somewhat in various sections of the area here concerned. In the rock country, from Malachi to Ingolf, *H. guttata* (subsp. *faxoni*) was most common; daily totals varied from eight to sixteen. At Wabigoon the species was but slightly in excess of its relative, *H. ustulata.* At Sioux Lookout and at Savanne this order was reversed, *H. guttata* being obviously less plentiful than *H. ustulata.* The reduction of *H. guttata* eastward is further borne out by the fact that we have no reports of occurrence for the townships around Dinorwic Lake. For Kenora *H. guttata* is slightly less plentiful than *H. ustulata.* Available breeding records include Sioux Lookout, Wabigoon and Minaki (the last mentioned, Baillie and Harrington, 1936–37). Young of the year (1937) first appeared out of the nest on June 19, at Wabigoon.
Specimens: 2 juvenals; 5 adults.

Hylocichla ustulata. SWAINSON'S THRUSH.—For the region as a whole, this is the most plentiful and universally distributed of the three representatives of the genus in the area. As outlined under the account immediately above, *H. ustulata* vies with *H. guttata* for predominance and exceeds it in the areas of deeper soils and spruce forests (often six to twelve daily at Sioux Lookout, Wabigoon and Savanne). Breeding records are as follows: Malachi (young of the year) and Wabigoon (nest building June 18). Summer occurrence records from localities not mentioned previously include Ingolf, Kenora, Dryden, Dinorwic Lake, Indian Bay, Shoal Lake and Allie Island. Specimens conform with the race *H. u. swainsoni.*
Specimens: 1 juvenal; 7 adults.

Hylocichla fuscescens. VEERY.—Not rare at most of the collecting and observation stations. Its absence at Savanne is in part attributable to the local lack of suitable ecological conditions. Its rarity at Sioux Lookout (one on June 29 and three on July 5) probably indicates a peripheral reduction. Westward it occurs at Minaki and at Malachi, where it was observed regularly and in appreciable numbers (maximum, twelve daily). Southward (Ingolf, Kenora, Wabigoon, Dryden, Allie Island and the Ontario portion of Indian Bay) it occurs regularly and not uncommonly. Although summer occurrence in numbers implies a breeding status, the only specific breeding records available are for Kenora (Baillie and Harrington, 1936–37) and for Malachi. Specimens collected clearly indicate that the population of this region represents the race *H. f. salicicola.*
Specimens: 1 juvenal; 8 adults.

Sialia sialis. BLUEBIRD.—Not plentiful but occurs throughout the region. One to four were recorded on half the twelve days afield at Ingolf where it was slightly

more numerous than at other stations. Found at Malachi, Sioux Lookout, Dinorwic, Wabigoon and Kenora. Old brulés and clearings about habitations and settlements are the sites usually occupied. Breeds at Kenora (Baillie and Harrington, 1936–37). Additional specific breeding records are: An occupied nest in a standing stub in a brulé at Wabigoon, June 18, 1937; Juvenals collected at Malachi. Specimens are characteristic of the nominate race.
Specimens: 2 juvenals; 4 adults.

Regulus satrapa. GOLDEN-CROWNED KINGLET.—Noted regularly at several of the Museum's collecting stations—Malachi, Sioux Lookout, Wabigoon and Savanne—most commonly at the last mentioned place where from two to ten were recorded daily. Also noted at Minaki, Dryden and Kenora. Young recently out of the nest were found at Malachi on July 15. Specimens represent the nominate race.
Specimens: 1 juvenal; 3 adults.

Regulus calendula. RUBY-CROWNED KINGLET.—The species (subsp. *R. c. calendula*) is somewhat more generally and plentifully distributed in the region than *R. satrapa.* Regular and plentiful occurrences were recorded at Minaki, Malachi, Sioux Lookout, Ingolf, Kenora, Wabigoon and Savanne. Two breeding records are available, for Kenora (Baillie and Harrington, 1936–37), and young of the year at Malachi.
Specimens: 1 juvenal; 1 adult.

Bombycilla cedrorum. CEDAR WAXWING.—From twelve to twenty-five individuals were recorded daily at most collecting stations, after the flocking season (at Malachi, Sioux Lookout, Kenora and Wabigoon). Also plentiful in the Ontario portion of Indian Bay, Galt Island, Redditt, Keewatin, Dinorwic, Dryden, Upsala and Minaki. Observed still to occur in flocks during the first two weeks of June at Ingolf in 1937 and at Shoal Lake in 1949. The earliest available breeding record concerns a nest being built on June 18, 1939, in the Dryden area. Our latest nesting evidence concerns a well developed but shell-less egg found in the oviduct of a female collected and dissected on June 30, 1937, at Wabigoon. Baillie and Harrington (1936–37) record the species breeding at Kenora.
Specimens: 9 adults.

Sturnus vulgaris. STARLING.—Although the Museum's first field party in this region (summer of 1937) did not observe the starling, its initial appearance there had been noticed slightly earlier by Mr. Paterson who communicated the following to the writer: "During a cold period of last winter, 1935–36, a pair of starlings took shelter on a southern slope at Kenora and stayed for about two weeks." The species was well established at Murillo in 1937 which place is just outside the area here concerned, and it had been found in the Port Arthur–Fort William area since the winter of 1930–31 (Dear, 1940). By 1947 the starling

was observed at Kenora in numbers (twenty, on June 19) and from one to twenty-five were observed daily, at Malachi and Sioux Lookout that year. The species is rather restricted to clearings, particularly settlements. First appearances of young starlings out of the nest were recorded for Kenora on June 15 in 1947 and June 13 in 1949.

Vireo flavifrons. YELLOW-THROATED VIREO.—One was observed on Galt Island in Shoal Lake on June 15, 1949; one at Thunder Lake, between Dryden and Wabigoon, in August, 1939; and the species was once observed at Kenora during early summer, though the details are not available.
Specimen: 1 adult.

Vireo solitarius. SOLITARY VIREO.—Fairly common and widely distributed. Observation lists made at Ingolf, Wabigoon, Savanne, Malachi and Sioux Lookout record from one to eight nearly every day. Also noted at Minaki. Race, *V. s. solitarius.*
Specimens: 8 adults.

Vireo olivaceus. RED-EYED VIREO.—By far the most common and generally distributed vireo and one of the most plentiful species of birds in the region. Daily totals for the species at the several collecting stations range up to fifty (Malachi, July 16, 1947); the lowest at Savanne (maximum twelve). General statements of prevalence in summer concern Indian Bay, Galt Island, Kenora, Shebandowan Lake, Dryden, Dinorwic, Minaki and White Dog Rapids. Some indication of the nesting period is conveyed by two available notes: One concerns nest building on June 18 at Kenora in 1930 and the other a nest with an incomplete complement of fresh eggs (two) at Wabigoon on June 17, 1937. Two other definite breeding records are available, one at Dryden on June 27, 1939, and the other at Malachi on June 28, 1947, the latter a nest only three feet from the ground in a paper birch sapling.
Specimens: 5 adults.

Vireo philadelphicus. PHILADELPHIA VIREO. Rather scarce but observed occasionally at Ingolf and Wabigoon in 1937, and at Malachi and Sioux Lookout in 1947. The species was observed on more than 25% of the eighteen days afield at the latter place, with a maximum of eight recorded on July 5.
Specimens: 4 adults.

Vireo gilvus. WARBLING VIREO.—Rare and most apt to occur about settlements in the more southern sections. Has been observed at Kenora in summer (Paterson). The nearest actual collected specimen, so far as the writer is aware, was taken at Indian Bay (Shoal Lake) in Manitoba, some thirty miles southwest of Kenora.

Mniotilta varia. BLACK AND WHITE WARBLER. Fairly common and generally distributed; seventh among the twenty-three species of summer resident warblers found in the region. Observed at Minaki, Malachi, Redditt, Sioux Lookout, Ingolf, Kenora, Dryden, Wabigoon, Dinorwic, the Ontario portion of Indian

Bay, Galt Island and Allie Island. The largest daily total (two observers) was eight, on two occasions, at Ingolf in 1937. The species was comparatively rare at Savanne where the forest was largely black spruce. Baillie and Harrington (1936–37) give breeding records for Kenora and the Ontario portion of Indian Bay of Shoal Lake.
Specimens: 3 adults.

Vermivora peregrina. TENNESSEE WARBLER.—Primarily a bird of the black spruce country producing an interrupted distribution but rated ninth in frequency among the warblers for the region as a whole. Commonly observed at Savanne in 1937 and at Sioux Lookout and Malachi in 1947. Observed occasionally in the Kenora area and in the Shoal Lake region.
Specimens: 3 adults.

Vermivora celata. ORANGE-CROWNED WARBLER.—A transient which is included here on the basis of one observed at Minaki (Cartwright) on August 16, 1937.

Vermivora ruficapilla. NASHVILLE WARBLER.—The most common of the twenty-three species of summer resident warblers recorded for the region, and it is widely distributed. Daily counts of from eight to twelve were frequent at Museum camps, with daily totals ranging from fifteen to thirty at Ingolf and Malachi. It occupies the more open forests including the black spruce forest, in fact, edge conditions generally. Young out of the nest were first observed on July 1, 1937, at Wabigoon, but young still in the nest were found there on July 9. The nominate race occurs in the region.
Specimens: 2 juvenals; 4 adults.

Parula americana. PARULA WARBLER.—Rare, contesting the position of rarest summer resident warbler of the region with the Cape May warbler or the black-throated blue warbler. One was collected at Malachi (*P. a. pusilla*).
Specimen: 1 adult.

Dendroica petechia. YELLOW WARBLER.—Fairly common but rather sporadic with a rating of tenth among the twenty-three species of summer resident warblers. Most plentiful at Ingolf, Kenora and Malachi; somewhat less numerous at Sioux Lookout. A few were recorded at Wabigoon, the Ontario portion of Indian Bay, Galt Island and at Dryden. A newly completed nest found at Kenora on June 15, 1947, was four feet from the ground in a gooseberry shrub. Breeding also established for Malachi. The yellow warbler of this region is referable to the nominate race.
Specimens: 1 juvenal; 5 adults.

Dendroica magnolia. MAGNOLIA WARBLER.—Common in the mixed evergreen forest of the region, rated sixth in point of numbers among the twenty-three summer resident warblers. Most numerous at Sioux Lookout and Wabigoon though regular and about as frequent at Malachi, Ingolf and Kenora. Observed also at Minaki and Redditt.
Specimens: 5 adults.

Dendroica tigrina. CAPE MAY WARBLER. A representative was identified at Dinorwic Lake in early June, 1940, and two were seen at Sioux Lookout on July 6, 1947.
Specimen: 1 adult.

Dendroica caerulescens. BLACK-THROATED BLUE WARBLER. A rare summer resident. A specimen was secured on June 17, 1947, at Wabigoon (*D. c. caerulescens*) and an individual observed on July 1 at the same place. Occurrence reports nearest to the region are those of Rowan (1922a) for the Manitoba portion of Indian Bay and Dear (1940) for Thunder Bay, Lake Superior.
Specimen: 1 adult.

Dendroica coronata. MYRTLE WARBLER. Very common, rated second most common of the twenty-three species of summer resident warblers. Daily totals of from a dozen to forty individuals were frequent at Malachi, Sioux Lookout, Ingolf, Wabigoon and Savanne. Reported as a common bird at Kenora where it breeds (Baillie and Harrington, 1936–37). Additional breeding records were established at Wabigoon, Sioux Lookout and Malachi. Summer occurrence reported for Minaki. Specimens are characteristic of the nominate race.
Specimens: 6 juvenals; 6 adults.

Dendroica virens. BLACK-THROATED GREEN WARBLER. Sporadic in occurrence and rated fourteenth in frequency among the summer resident warblers of the region. Most plentiful in the mixed evergreen forest at Sioux Lookout where from one to ten were observed daily. It was next most frequently observed at Kenora. Found rarely at Malachi, Wabigoon and Savanne. Specimens are characteristic of the nominate race.
Specimens: 3 adults.

Dendroica fusca. BLACKBURNIAN WARBLER. Common and generally distributed. Fifth in point of numbers compared with all summer resident warblers; two to ten daily at Malachi; two to twenty at Sioux Lookout; one to twelve at Ingolf; two to fifteen at Wabigoon; one to eight at Savanne. Reported as frequent or present at Minaki, Kenora, Dryden, Galt Island and Echlin's Island. Young of the year being fed by parents were observed at Savanne on July 8, 1937; parents feeding young at Kenora in August, 1943; and a juvenal was collected at Malachi.
Specimens: 2 juvenals; 6 adults.

Dendroica pensylvanica. CHESTNUT-SIDED WARBLER. Eighth in point of numbers among the summer resident warblers. Two to fifteen daily at Ingolf; one to eight daily at Wabigoon; one to five daily at Malachi; one to three daily at Sioux Lookout; "abundant" at Indian Bay; common at Kenora; frequent at Redditt, Allie Island and Galt Island; present at Dinorwic Lake, Minaki and Shebandowan Lake. Specific breeding evidence is available from Kenora (Baillie and Harrington, 1936–37).
Specimens: 6 adults.

Dendroica castanea. BAY-BREASTED WARBLER.—Local; uncommon for the region as a whole; rated eleventh among the twenty-three summer resident species of warblers found in the region. Its sporadic occurrence is apparently brought about by its preference for mature coniferous forests especially white spruce. Found regularly (three to twelve daily) at Sioux Lookout. Occurrence of this warbler in appreciable numbers, and breeding, has been reported from immediately south of the area covered by this report (Snyder, 1938).
Specimens: 2 adults.

Dendroica striata. BLACK-POLL WARBLER.—A transient which may occur rarely during the summer period. Observed on Echlin's Island (E. Keighley) in August, 1938. An August transient has been reported for the region immediately to the south (Snyder, 1938).

Dendroica pinus. PINE WARBLER.—Scarce, sporadically distributed and associated with the pine country. Rated eighteenth in point of numbers among the twenty-three summer resident warblers. One to four noted on approximately half the days afield at Malachi in 1947; observed on two occasions at Ingolf in 1937; noted occasionally in 1947 and 1949 at Kenora; identified on Echlin's Island in August, 1930. Race, *D. p. pinus.*
Specimens: 8 adults.

Dendroica palmarum. PALM WARBLER.—Of particular interest was the observation that this species is found in two distinct types of habitat, namely, in dry forests of jack pine (both park-like situations of moderately mature trees, and dense stands of young trees) and in wet black spruce bogs, usually of an open nature. Common in the sparse jack pine on rock at Ingolf; found in the same habitat at Malachi but also in spruce bogs there; occurred sparingly in both dense young jack pine and in sparse black spruce at Wabigoon; scarce but present in sparse black spruce at Sioux Lookout; fairly common in the black spruce at Savanne; and occurs at Kenora. For the region as a whole the palm warbler rates thirteenth among the twenty-three summer resident warblers. Breeding records were established for Wabigoon, Savanne and Malachi and reported for the Ontario portion of Indian Bay. Variation in the song of this species was noticed. In addition to the usual short, simple musical trill, males apparently on nesting territory rendered a loud, rolling "weet, weet, weet, weet, weet", with a machine-like rhythm and a rattle-like quality. The race of the region is *D. p. palmarum.*
Specimens: 2 juvenals; 7 adults.

Seiurus aurocapillus. OVEN-BIRD.—Common and widely distributed though found largely in the deciduous or mixed forest habitat. Rates third in point of numbers among the twenty-three summer resident warblers, exceeded only by the Nashville and myrtle warblers. The species was listed daily in numbers up to a dozen or fifteen at Malachi, Sioux Lookout, Ingolf and Wabigoon. It was less plentiful at Savanne. Other records available show it to be common at Kenora and frequent in Southworth and Hartman Townships of the Dinorwic Lake area. Breeding records are available for Malachi; Ingolf (newly completed nest beneath

a poplar-birch stand, June 3); Wabigoon (two nests, each with four young, June 21); Hartman Township, Dinorwic area, nest and four eggs, July 5); and Kenora. Specimens secured are characteristic of the nominate race.
Specimens: 1 juvenal; 4 adults.

Seiurus noveboracensis. NORTHERN WATER-THRUSH. -Scarce for the region as a whole, rating seventeenth in point of numbers among the summer resident warblers. Most frequently found in areas where the soil is relatively deep and where swamps and mixed woods exist. At Kenora, a pair observed on June 8, and one on June 16, 1947; one on June 1, 1949. One to four were observed on one-third of the days afield at Sioux Lookout (in 1947) and a similar status prevailed at Wabigoon (in 1937). Occurs at Savanne and Minaki. A breeding record for the Ontario portion of Indian Bay is recorded (Baillie and Harrington, 1936-37). Specimens secured are provisionally referred to the race *S. n. notabilis*. The dorsal colour is not strikingly grey but ventral yellow is dilute.
Specimens: 3 adults.

Oporornis agilis. CONNECTICUT WARBLER. -Though rated as low as sixteenth among the summer resident warblers, the population of this species is probably as dense as in any area of similar size in Ontario. From one to eight were observed almost daily at Ingolf. It was rare at Wabigoon but three were recorded there on June 30, 1937. Three were recorded at Savanne (July 8, 1937) and three at Sioux Lookout (two June 23 and one June 24, 1947). At Malachi one was seen on July 14, two on July 15, one on July 17 and two on July 19, 1947. Three were observed in the Kenora area between June 3 and 10, 1949. The species appears to be strictly a bird of the black spruce habitat, preferring those areas where the trees are well developed but the stand not dense.
Specimens: 7 adults.

Oporornis philadelphia. MOURNING WARBLER. Common, occurring in clearings and edge conditions throughout the region; rated fourth among the summer resident warblers and exceeded in numbers only by the Nashville warbler, myrtle warbler and oven-bird. However, its numerical status was only slightly in excess of the blackburnian and magnolia warblers. Local records are as follows: Three to twelve daily at Malachi; one to ten daily at Sioux Lookout; two to fifteen daily at Ingolf; one to twelve daily at Wabigoon; one to seven daily at Savanne. Found regularly and plentifully at Kenora, Redditt, Southworth and Hartman Townships of the Dinorwic area, and listed for Minaki. A female collected on July 17 at Malachi shows a peculiar pigment deficiency. Absence of dark pigment in an area on the breast produces a whitish spot instead of the normal gray colour; on the sides and back of the crown the feathers are pure white. On the right side of the back there is a spot of clear yellow, approximating one-quarter inch in diameter; dark pigment which normally combines with yellow pigment and renders the back feathers green is deficient.
Specimens: 7 adults.

Geothlypis trichas. MARYLAND YELLOW-THROAT.—Twelfth among the summer resident warblers, consequently it is regarded as rather uncommon for the region as a whole and approximates the frequency of the bay-breasted, palm and black-throated green warblers. Its rarity at Wabigoon, Savanne and Sioux Lookout (one to three occasionally) is interpreted as a peripheral reduction northeastward in the region. It was noted rather plentifully at Malachi (two to eight nearly every day), Ingolf (two to six nearly every day), Kenora and the Ontario portion of Indian Bay.

Comparisons of male specimens with comparable material from eastern and southern Ontario show that the birds from the west are slightly brighter green dorsally. The pale band on the forehead is wider and more nearly white, on the average. The yellow of the throat is near to "wax yellow". The majority show an extension of yellow posteriorly on the ventral surface which does not characterize the appearance of most eastern specimens. Six adult males average 54.7 mm. in chord of wing (min. 52.2; max. 57.1). In all the colour characters these specimens show affinities toward specimens from Manitoba and further west, and it is obvious that population contact is in that direction since the species is wanting or extremely rare eastward north of the Great Lakes. With the reservation that these specimens are not characterized by their greyness but rather by a degree of richness and extensiveness of yellow as compared with eastern birds, the series is referred to the northern prairie race, *G. t. campicola* of Behle and Aldrich (1947).

Specimens: 8 adults.

Wilsonia pusilla. WILSON'S WARBLER.—Scarce; rated twentieth in point of numbers among the summer resident warblers. Occurrence was noted only at northeasterly stations which is consistent with the known boreal range of the species and correlated with ecological conditions of the region. The swampy willow and alder swales and scrubby swamps which it occupies are less numerous and extensive in the shallow-soiled, rock country of southern and western sections. Two were observed at Savanne on July 13, and one on July 15. At Sioux Lookout four were noted on July 4 and two on the following day. Specimens collected are characteristic of the nominate race.

Specimens: 3 adults.

Wilsonia canadensis. CANADA WARBLER.—Rather uncommon but widely distributed; rated fifteenth among the summer resident warblers. One to four were observed daily at Sioux Lookout and one to six at Ingolf. Observed irregularly at Wabigoon; scarce at Malachi.

Specimens: 4 adults.

Setophaga ruticilla. REDSTART.—Its population for the region as a whole must be rated as sparse, ranking nineteenth among the twenty-three summer resident warblers. A total of five was observed at Sioux Lookout; eight at Wabigoon; three at Malachi; and one at Ingolf. A few were reported for Kenora. Allie

Island, northern sections of Shoal Lake, and Minaki. Plentiful in the Ontario section of Indian Bay.

Concerning geographical variation of the redstart, two races are currently recognized by authorities. Oberholser (1938) originally differentiated the birds of the northwestern parts of Canada (and the western United States) from those of the east on the basis of (males) "smaller size, smaller orange or yellow wing-spot"; (females) also smaller size, and "paler, more grayish, less conspicuously olivaceous, upper surface". Later, Burleigh and Peters (1948) recognized that this form ranged throughout the north, extending across the continent from British Columbia to Newfoundland. They defined the race as follows: "Males are readily distinguished from the nominate race, represented by breeding birds of the eastern United States, by their smaller measurements, and by the noticeably smaller orange speculum. Females and sub-adult males are even more distinct, the upper parts being grayish rather than olive green, and the yellow speculum so reduced that in many cases only a faint trace of yellow is visible". Still more recently Wetmore (1949) reviewed the subject and states that "adult males from the far north and the far south, and from eastern and western localities may not be distinguished with certainty on any character, or combination of characters. . . . Size, within the usual limits of individual variation, is identical in the various areas. . . . There seems to be a tendency for more birds to have a reduced wing spot in the north . . . [but adult males] may not be separated geographically on any trenchant characters." Females "from the north are slightly *darker gray* above, while those from the south are faintly lighter gray and slightly more greenish". He recognized a similar distinction between sub-adult males from the two areas. There is then, agreement that two populations should be recognized and there is no disagreement as to the names to be applied, *S. r. ruticilla* (Linnaeus) for the southeast with the type locality in Virginia, and *S. r. tricolora* (Muller) for the northern and northwestern population, with a type locality in Cayene, French Guiana (winter). Disagreement arises only with respect to the characters on which the two forms are distinguished. Admittedly the specimen material at hand cannot resolve the matter but should contribute toward that end. Twenty-four adult males collected in Ontario between June 1 and July 23, in central Temiskaming, Sudbury and Algoma Districts, north and west through Cochrane, Thunder Bay and Kenora Districts including the Patricia portion of the latter, are compared in the table below with eight adult males taken between June 11 and July 15 in Prince Edward, York, Norfolk and Essex Counties. Specimens from intervening areas were excluded although it seems evident that a fairly sharp division of the two populations may be made through the northern part of southern Ontario (Georgian Bay to Mattawa). A complete complement of measurements was not available for every specimen. Total length, wingspread (in mm.) and weight (in gm.) measurements were taken by collectors. The others were made by the writer from specimens. The number of measurements for each feature is indicated in parentheses; this is followed by the minimum and the maximum. The arithmetic mean, together with its standard error when calculated, is in brackets.

	Length	Chord of wing	Tail	Exposed culmen	Width of beak at nostril	Wingspread	Weight
Northern ♂♂	(24) 122-137 [129±1.7]	(24) 58.6-63.2 [61±.23]	(24) 50–56 [53.2]	(24) 7–9.5 [8.4]	(24) 3.3–4.6 [4.1]	(14) 183–193 186.6	(6) 7.5–8.2 [8]
Southern ♂♂	(5) 127-137 [133±2.2]	(8) 62–67.6 [64.8±.75]	(8) 51–61.5 [55.5]	(8) 8–9 [8.8]	(8) 4–4.6 [4.4]	(1) 191	(1) 8

All measurements indicate a trend toward larger size of adult males in the south. Total length, for example, shows an observed average difference of 4 millimetres (SE of the difference, 3.4). More significant is the wing measurement with an observed difference of 3.8 millimetres between the averages of the two populations (SE of the difference, .59). Although the wing of the northern Ontario population shows only about a 6% smaller size the character appears constant.

With respect to colour, adult males from central and northern Ontario tend toward an increase of black in their plumage. This results in some reduction of the orange speculum and on the average black extends further posteriorly on the sides of the ventral surface, usually as a broken, not a solid, pattern.

Yearling males and females from the north show a reduction in the yellow speculum, on the average, in some to the point of virtual concealment, but this should be worked out quantitatively with a larger series than is available. The series is inadequate for comment with respect to dorsal tone and colour of yearling males and adult females. Western Ontario specimens agree with the northern population in size. The evidence presented supports the racial definition of Burleigh and Peters (*op. cit.*) but does not greatly strengthen the case for nomenclatural recognition.

Specimens: 1 subadult; 3 adults.

Passer domesticus. HOUSE SPARROW.—Restricted to settlements where it nests about man-made structures in summer and manages to survive in winter. Numerically the species is found in direct ratio to the size of the human community. Approximately a dozen pairs were established at both Ingolf (where they nested about the railway water tank, etc.) and at Wabigoon. Twice that number was observed daily at Kenora in 1947 and 1949 (first young out of nest on June 7, 1949). Small populations were established at Redditt, Upsala, Sioux Lookout and Malachi.

Specimens: 2 adults.

Sturnella neglecta. WESTERN MEADOWLARK.—Scarce in the region as a whole, probably largely because of the small proportions of suitable terrain. At least three singing males were heard in the farm country around Dryden on June 28, 1937. A rare summer resident in the Kenora area.

Xanthocephalus xanthocephalus. YELLOW-HEADED BLACKBIRD.—Observed once in summer (Paterson) at Quibell. There are occurrence records in this latitude at this season as far east as Lake Nipigon (Snyder, 1928).

Agelaius phoeniceus. RED-WING.—Colonies are scattered through the region in accord with the occurrence of marsh habitat. The species was ranked as common at Malachi (breeding), Sioux Lookout (breeding), Ingolf (breeding), Kenora ("breeds"), Redditt (breeding), Dryden, Wabigoon (breeding), Dinorwic, Allie Island and Indian Bay, one or more colonies being established at all these places. Smaller colonies were found at Savanne, Sultana Island and Thompson's Island. The race of this region is *A. p. arctolegus.*
Specimens: 2 juvenals; 19 adults.

Icterus galbula. BALTIMORE ORIOLE.—Not a wilderness bird, choosing the vicinity of habitations and otherwise sporadic in occurrence. Heard at Ingolf on June 8 and 9, 1937 but they were apparently transient. Three recorded at Malachi on July 11; four on July 14 and again on July 16, 1949. Known to nest at that station. Has occurred at Kenora, where it has been known to breed, since 1929. Recorded at Redditt.
Specimens: 2 juvenals; 5 adults.

Euphagus carolinus. RUSTY BLACKBIRD.—On July 8, 1937, a total of twenty-two representatives of this species was discovered along the alder-grown banks of a sluggish tributary of the Savanne River. Juvenal birds recently out of the nest were included. A few were subsequently observed (July 10 and 13, 1937) in this same place. Approximately twenty-five birds, including immatures, were observed between August 17 and 19, 1952, at Perrault Falls and Perrault Lake. The species occurs in summer sporadically northward and eastward in the province, but it was not recorded for southern Thunder Bay by Dear (1940), in western Rainy River District (Synder, 1938), nor was it proven to breed in Minnesota (Roberts, 1932).
Specimens: 3 juvenals; 3 adults.

Quiscalus quiscula. GRACKLE.—Rather generally distributed and not uncommon, nesting in evergreens about settlements and in marshy and shore areas in more isolated situations. It was regular and very numerous at Malachi (10 to 35 daily); common at Sioux Lookout (2 to 25, almost daily); regularly and fairly common at Ingolf (1 to 12 daily); common at Wabigoon (10 to 30 daily); and fairly common at Savanne (2 to 10 nearly every day). Reports indicate it is common in the Kenora area, through the northern portions of Shoal Lake, and at Redditt, and frequent in the Dryden area, at Dinorwic, and in Southworth and Hartman Townships. Specific breeding records are: Nest twenty feet up on a horizontal limb of a spruce at Kenora, May 26, 1949; parent carrying nestling excreta from nest situated in low vegetation in a marsh at Ingolf on June 10; two nests, three and four eggs respectively, at Wabigoon on June 28; and parents with young at Shebandowan Lake. The race of this region is *Q. q. versicolor.*
Specimens: 9 adults.

Molothrus ater. COWBIRD.—Common in the southern and western part of the region with which we are here concerned but becoming rare eastward. The range of the species is interrupted across Ontario, the populations east and west of the Great Lakes having no regular contact north of that body of water. From two to fifteen were listed daily at Malachi; eight to twenty daily at Ingolf; one to twenty-five daily at Kenora; found plentifully in the Ontario portion of Indian Bay; and from one to nine were recorded daily at Wabigoon. It was rare at Sioux Lookout (one on June 29, four on July 4, and one on July 9) and noted rarely at Dinorwic Lake. At Ingolf it was estimated that males outnumbered females two to one. The common utterances of the cowbird in this section of the province differed from those heard in the east. A common sound, often produced in flight, was a "wisp-sputter-r-r-r". They also uttered the phrase, "oh-keedoke", accented on the first syllable. The population of the region represents an eastern extension of the race *M. a. artemisiae.*
Specimens: 18 adults.

Piranga olivacea. SCARLET TANAGER.—Found sporadically in mixed forest throughout the region. Occasionally observed in the northern Shoal Lake area, at Kenora, and in Southworth Township of the Dinorwic area. From one to four were observed at Ingolf almost daily; one to seven fairly regularly at Malachi; one to three occasionally at Wabigoon; and rarely at Sioux Lookout (one, July 3 and one, July 8). An adult male in fall plumage was observed on August 18, 1952, ten miles south of Perrault Falls. These records indicate a diminution of numbers northeastward. A male specimen collected at Ingolf displayed a colour deficiency, the body feathers being nearer orange than scarlet. Our only definite breeding record is for Malachi.
Specimens: 1 juvenal; 13 adults.

Pheucticus ludovicianus. ROSE-BREASTED GROSBEAK.—A bird of the mixed forest and therefore its local distribution is governed somewhat by prevailing ecological conditions but geographically its numbers diminish northeastward. Not uncommon at Kenora; from two to six observed daily at Ingolf; one to nine daily at Malachi; one to six on half the days afield at Wabigoon; and noted on two occasions (one, July 7 and two, July 9) at Sioux Lookout; rare at Dinorwic Lake and Southworth Township; and immediately south of Perrault Falls.
Specimens: 3 juvenals; 14 adults.

[*Guiraca caerulea.* BLUE GROSBEAK.—The inclusion of this species is based entirely on a published sight record (Marvel, 1950) of a male in adult plumage observed on June 25, 1949, at Cliff Lake. This record must be considered hypothetic for the present. There is no occurrence substantiated by a specimen for the whole of Ontario and, so far as is known, none for the neighbouring province (Manitoba) or states (Minnesota and Michigan). The western race of the species normally occurs in western Iowa and the eastern race occurs in southern Illinois and Indiana. Occasional stragglers have been reported from southern Wisconsin. The northern range boundary as described may well be breached at any period or place but extralimital extensions which involve the addition of a species new to a province should be supported by a collected specimen.]

Passerina cyanea. INDIGO BUNTING.—Two occurrences are as follows: One found [dead] at Sioux Lookout in June (Baillie and Harrington, 1936–37) and a pair found established in a sunny thicket along a road through mixed woods near Wabigoon on June 22, 1937. Circumstances such as the date, the situation, the behaviour of the pair and the enlarged gonads of the male all support the supposition that this was a breeding pair. Dear (1940) records this species as a rare but regular summer resident of the Fort William–Port Arthur region.
Specimen: 1 adult.

Hesperiphona vespertina. EVENING GROSBEAK.—A number of summer occurrences for the region are given chronologically, together with such evidence of breeding as is available: Present and bred at Indian Bay in 1920; numbers observed at Long Pine Lake (near Ingolf) on July 3, 1920; Hales (1927) records having observed the species at Minaki in July [prior to 1923]; not uncommon and bred in the Kenora region in 1931 (Baillie and Harrington, 1936–37); noted every day between August 14 and 17, 1937, at Minaki, groups totalling up to nine, and on August 16 adults were seen feeding young; one observed at Sioux Lookout on July 1, and one at Malachi on July 26 in 1947; pairs observed on two occasions at Kenora during the latter part of June, 1947, and from one to five on three days during early June, 1949.

Carpodacus purpureus. PURPLE FINCH.—Observed daily at Malachi (maximum, 15) where it breeds; Sioux Lookout (maximum, 8); Ingolf (maximum, 12); Wabigoon (maximum, 8); Savanne (maximum, 8). Present at Kenora (adults with young August 10, 1943), Allie Island, Dryden, and the Ontario portion of Indian Bay. Specimens do not differ from the nominate race.
Specimens: 1 juvenal; 7 adults.

Pinicola enucleator. PINE GROSBEAK.—One observed at Sioux Lookout on June 24, 1947, and another in early June, 1940, at Dinorwic Lake.

Spinus pinus. PINE SISKIN.—Observed with regularity but with great variation as to numbers at Malachi (three to fifty daily); Sioux Lookout (two to twenty-five); Ingolf (two to forty-seven); and Savanne (four to eighteen). Noted rarely at Wabigoon (two, June 25 and one, June 30); Kenora (one to six). Observed in the northern Shoal Lake area. Breeding evidence is available for Kenora and Savanne. The nominate race is represented in the region.
Specimens: 1 juvenal; 6 adults.

Spinus tristis. AMERICAN GOLDFINCH.—Occurs throughout the region, but more frequent about clearings, settlements and open forest situations; most plentifully in western sections. At Malachi, three to fifteen were recorded daily; one to eight, fairly regularly at Sioux Lookout; four to fifteen daily at Ingolf (pairing by June 12 in 1937); one to ten daily at Wabigoon; observed twice (two July 7 and one July 9) at Savanne. Fairly common in the Kenora area where it breeds (pairing by June 10 in 1949). Observed in the Dryden area and Redditt.
The goldfinch of this region shows a tendency toward the western race: The

yellow of the majority of males is purer than is displayed by eastern birds; the white pattern on the tail and wings is more extensive on the average; and there is a tendency for the black cap to extend farther posteriorly. Females are slightly brighter in colour than eastern birds. In size, representatives of this population correspond more closely to eastern birds. It seems best to consider the population intermediate between the nominate race and *S. t. pallidus* with the comment that in the series collected those from farthest west, at Ingolf, are most like *S. t. pallidus* in colour, and on the same basis those from Sioux Lookout could be referred to as *S. t. tristis*. The average measurements of eight of the male specimens listed below, are—length, 124.3; chord of wing, 71.6; tail, 47; exposed culmen, 10; weight, 13.1 gms.
Specimens: 16 adults.

Loxia curvirostra. CROSSBILL.—Flocks of from four to twenty were encountered daily from July 24 to August 6 in 1947, at Malachi. Not rare as a summer resident in the Kenora area. Both of the localities mentioned are essentially pine country. Average measurements of six adult males are: Length, 155.8; wing-spread, 275.6; chord of wing, 90.1; tail, 54.6; chord of bill from anterior of nostril, 14.4; depth of bill at nostril, 9; weight, 31.8 gms. Their red colour tends strongly toward orange. These specimens agree closely with the form *L. c. sitkensis* as originally described.
Specimens: 6 adults.

Loxia leucoptera. WHITE-WINGED CROSSBILL.—Met with only in the spruce country at Savanne where individuals and small flocks were noted daily during the second week of July, 1937.

Passerculus sandwichensis. SAVANNAH SPARROW.—Rare at Malachi; regular and fairly numerous at Sioux Lookout (one to nine daily); common at Wabigoon (two to fifteen daily); regular and not uncommon at Savanne (one to six daily); fairly common in the Kenora area; listed for Hartman Township of the Dinorwic region and for the Dryden area; and fairly general distribution in the Ontario portion of the Indian Bay region. A nest and four eggs was found on June 21, 1937 at Wabigoon (Baillie and Harrington, 1936–37). It is of interest to note that this species is frequently found about the margins of bog lakes in this region. The race of the region is *P. s. oblitus* (Peters and Griscom, 1938).
Specimens: 23 adults.

Passerherbulus caudacutus. LECONTE'S SPARROW.—It is difficult to estimate the numerical and distributional status of an inconspicuous species such as this, but on available evidence it does not occur in the rock country and it is rare and local elsewhere. On June 26, 1937, near Wabigoon, in a small slough characterized by clumps and tufts of grasses or sedges, an area of not more than half an acre within an extensive meadow, a singing male was observed. The bird uttered what was apparently an alarm note, "tilloc" as it flew. A singing male was observed in a low, grassy area west of the town of Sioux Lookout on June 29, 1947.
Specimen: 1 adult.

Pooecetes gramineus. VESPER SPARROW.—Fairly common but found only in the dry clearings or sparsely wooded terrain more characteristic of the rock country to the west. Details of occurrence are: From one to twelve recorded regularly at Malachi; fairly common at Ingolf (one to eight daily); fairly common at Kenora and observed at Redditt. At Wabigoon and Dryden where there was extensive farmland the species was fairly common; occasional at Sioux Lookout. Baillie and Harrington (1936–37) record a nest with four eggs found at Wabigoon on June 21, 1937, and breeding status was established at Malachi in 1947. The series of specimens collected indicates that the population of this region is referable to the race *P. g. confinis*, though they are somewhat intermediate with nominate race.
Specimens: 1 juvenal; 21 adults.

Junco hyemalis. SLATE-COLORED JUNCO.—Common at western collecting stations (Malachi; Ingolf and Kenora) and only slightly less so at Sioux Lookout, Savanne and Wabigoon. Additional occurrence reports are available from Hartman and Southworth Townships in the Dinorwic area, Echlin's Island, Allie Island, Dryden and Minaki. Baillie and Harrington (1936–37) record two breeding records from Kenora. A nest with four eggs was found on the ground beneath bracken in a jack pine woods at Ingolf on June 8, 1937; young out of the nest but being fed by parents were observed at Wabigoon on June 22, and a similar observation was made at Savanne on July 12, both in 1937; a nest with five eggs was found on July 3, 1939, at Dryden; for the Dinorwic region, a nest containing three eggs (in a spruce swamp) was found in Hartman Township on June 8, and another containing two eggs and two newly hatched young was observed in Southworth Township on June 20, both in 1946. Breeding evidence was secured at Malachi. The nominate race occurs in the region.
Specimens: 2 juvenals; 11 adults.

Spizella passerina. CHIPPING SPARROW.—One of the most plentiful of the sparrows, exceeded only by the white-throated and song sparrows in numbers. Observed commonly and regularly at Malachi, Ingolf, Kenora, Sioux Lookout, Wabigoon and Savanne. Breeding evidence was secured at Malachi and Sioux Lookout. Occurrence records, some of which indicate a plentiful status, were reported for Longbow Lake, Minaki, Upsala, Dryden, Dinorwic, Hartman and Southworth Townships of the Dinorwic area, Echlin's Island, northern parts of Shoal Lake, and the Ontario portion of Indian Bay. Breeding status was established for Malachi, Sioux Lookout, Kenora, Longbow Lake, Wabigoon, Savanne and Indian Bay. An adult male collected on June 11, 1937, at Ingolf was singing a song indistinguishable from the song of the clay-colored sparrow. Chipping sparrows from western Rainy River District were referred to the form, *S. p. arizonae* (Snyder, 1938) on the basis of size (averaging somewhat larger than specimens from southern Ontario) and tone (paler). With a larger series from western Ontario additional comment can be made. The seventeen adult males collected in the region covered by this report present the following minimum,

maximum and average measurements: Length 134–143 (138.5); chord of wing, 68.1–75.6 (71.2); tail 57–62.5 (59.3); chord of exposed culmen 9–10 (9.2); wingspread (seven specimens) 210–235 (222.8); weight in gms. (six specimens) 11.6–12.6 (12.1). For comparison, the measurements of fifteen adult males, collected during the nesting season in the southern counties of Ontario, Quebec (south of the St. Lawrence) and northern Ohio, are here presented: Length 127–140 (134.2); chord of wing 66–71.2 (69.1); tail 54–59 (56.4); chord of exposed culmen, 8–9.5 (8.8). Thus there is a trend toward larger size in the western Ontario series. Furthermore, these specimens tend to be paler than those from the southeast. In more detail, the black shaft markings of the dorsal feathers of western specimens average narrower and the brownish margins slightly paler and not as reddish brown. The grey of the plumage is also somewhat paler, including the ventral surface, and the throat of the majority is nearly white. The result is a somewhat sharper contrast in the dorsal pattern than in southeastern specimens. A noteworthy observation is, that a large series of specimens now available from throughout central, northern, and northwestern Ontario shows the same trend. Also specimens of this type occur westward across Canada at least to northern Alberta. If birds displaying these characters occupied a more restricted zone lying in a geographically intermediate position, one would readily interpret them as representing taxonomic intermediates between *S. p. passerina* and *S. p. arizonae*. But the region they occupy is vast and not geographically intermediate. Ecologically, it is the northern evergreen forest. To refer the population of this region to either *S. p. arizonae*, or the nominate race, conceals the facts that they do not conform precisely with either. Recognition of them as a distinct race would admittedly have to be based on slight differences.
Specimens: 3 juvenals; 20 adults.

Spizella pallida. CLAY-COLORED SPARROW.—In 1937 one to seven fairly regularly at Ingolf; one to ten observed daily at Wabigoon; one observed at Savanne on July 10. In 1947 one was observed at Sioux Lookout on June 30. Occasional at Kenora and Redditt. Breeding evidence was secured at both Ingolf and Wabigoon, and Baillie and Harrington (1936–37) record the breeding status of the species at Kenora.
Specimens: 4 adults.

Zonotrichia albicollis. WHITE-THROATED SPARROW.—Probably the most plentiful of all species of birds in the region, a position challenged only by the song sparrow and red-eyed vireo. There would be no error in scoring the species as a summer resident for all place names mentioned in the text. Precise breeding evidence is available only for Kenora, Wabigoon and the Ontario portion of Indian Bay.
Specimens: 6 adults.

Melospiza lincolnii. LINCOLN'S SPARROW.—Fairly common at Savanne (two to twelve daily); few at Ingolf and Wabigoon (one to three occasionally); scarce at Sioux Lookout (one on three occasions), Malachi (one on July 14), and at Kenora (one June 8, 1949). Singing males at all the places mentioned above,

and enlarged gonads of specimens collected provide only circumstantial evidence of breeding. Race, *M. l. lincolnii.*
Specimens: 8 adults.

Melospiza georgiana. SWAMP SPARROW.—Although this species is found throughout the region its numbers vary with ecological conditions. Found commonly at Savanne and Malachi (one to fifteen daily); fairly common at Sioux Lookout and Wabigoon (one to ten, fairly regularly) and regularly but in smaller numbers at Ingolf and Kenora. Summer occurrence records are available from Redditt and the Ontario portion of Indian Bay. Young just out of the nest were observed and collected at Malachi and Savanne. The race of the region is *M. g. erycripta* (see Godfrev, 1949).
Specimens: 2 juvenals; 6 adults.

Melospiza melodia. SONG SPARROW.—Very common and widely distributed. Daily totals ranging from ten to twenty were not unusual at all collecting stations. Breeding evidence is available for Malachi, Ingolf, Indian Bay, Kenora, Wabigoon and Savanne. Occurrence records are available from Minaki, Sioux Lookout, Redditt, Shebandowan Lake, Dryden, Dinorwic Lake (including Laval, Brownridge, Southworth and Hartman Townships of that region) and Allie Island. The race of the region is *M. melodia juddi.*
Specimens: 2 juvenals; 30 adults.

SUMMARY AND DISCUSSION

The foregoing lists 170 species of birds. Reported occurrence of *Eremophila alpestris* is rejected, the original basis being found erroneous. *Ectopistes migratorius* is now extinct. *Catoptrophorus semipalmatus*, *Pica pica* and *Guiraca caerulea* are included hypothetically. Fifteen species listed occur in summer but either fortuitously or as transients.[3] The total of extant summer resident species is 150. Occurrence of 117 of these (approximately 78%) is substantiated by specimens. Definite breeding evidence was secured for 95 species (approximately 65%). In addition to the distributional facts obtained the specimens secured, totalling 739, constitute a notable addition to the Museum's comparative collection.

In view of similar surveys in eastern Ontario, the present survey shows that many species extend their range farthest north in western Ontario. Approximately 15% of the summer resident birds reported are more characteristic of austral rather than boreal geographical regions. This may be correlated with the northward swing of summer isotherms in the continental interior. In contradistinction to this aspect of the region's avifauna, approximately 10% of the species found resident in summer are usually regarded as characteristically boreal. This may be accounted for indirectly and in part by a background of geological events

[3]*Chen caerulescens, Buteo lagopus, Tringa solitaria, Totanus melanoleucus, Totanus flavipes, Erolia minutilla, Ereunetes pusillus, Lobipes lobatus, Larus delawarensis, Larus pipixcan, Hydroprogne caspia, Tyrannus verticalis, Vermivora celata, Dendroica striata* and *Xanthocephalus xanthocephalus.*

favouring the formation of deep cool lakes and bog conditions. Thus we have co-existent in this region, in addition to wide-ranging forms, an appreciable representation of birds characteristic of climatic extremes. Examples: *Cathartes aura—Perisoreus canadensis*; *Melanerpes erythrocephalus—Picoides tridactylus*; *Dumetella carolinensis—Parus hudsonicus*; *Vireo flavifrons—Vireo philadelphicus*; *Icterus galbula—Euphagus carolinus*.

Other factors conducive to variety in the avifauna include the forest which is regarded by Halliday (1937) as an extension of the Great Lakes–St. Lawrence Forest. It is essentially of mixed composition but predominantly coniferous. The multiple plant association of this type of forest produces a variety of ecological niches each occupied by avian elements adapted to them. Also the geographic proximity of the region to the plains makes possible the penetration and establishment of campestrian elements in existing pseudo-prairie openings of the forest. Certain anthropogan changes of the landscape—deforestation including forest fires, settlements, farms, roads and railways— have undoubtedly affected the avifauna of the region, probably increasing species representation and certainly increasing the frequency of some. None of these alterations has attained proportions which would eliminate any indigenous bird species.

Comparison of specimens collected, of species known to vary geographically, shows that a considerable number are represented in western Ontario either by races of western distribution or display genetic influence from that direction. Only two species found suggest a western extension of characteristically eastern forms (*Anas rubripes* and *Dendroica caerulescens*). Obviously faunal influx or peripheral pressure is from the south and west.

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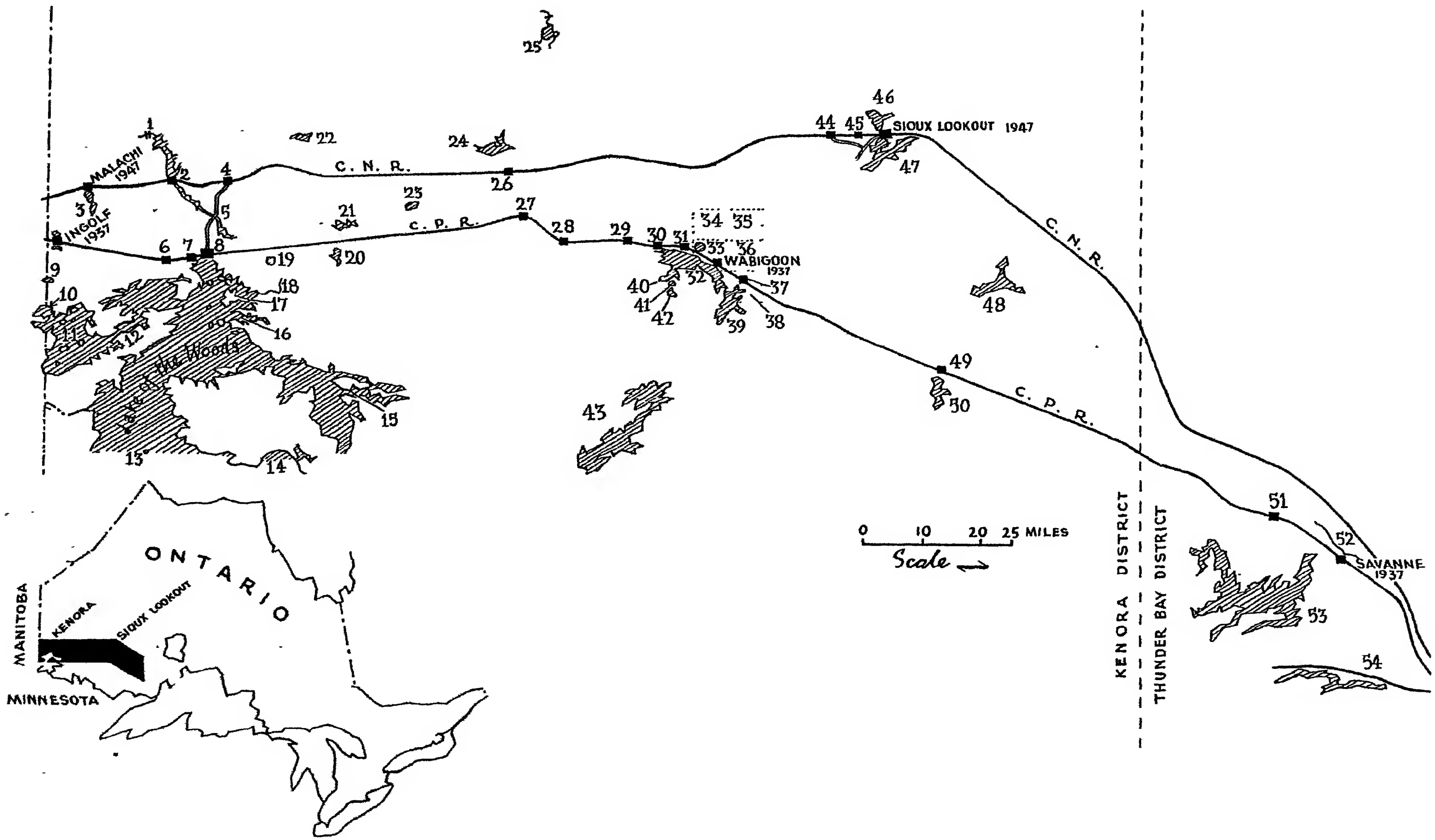
MALACHI 1947
INGOLF 1937
C. N. R.
C. P. R.
SIOUX LOOKOUT 1947
WABIGOON 1937
SAVANNE 1937
of the Woods
0 10 20 25 MILES
Scale
KENORA DISTRICT
THUNDER BAY DISTRICT
ONTARIO
MANITOBA
KENORA
SIOUX LOOKOUT
MINNESOTA

EXPLANATION OF PLATE

The various numbers refer to the place names that are used in the text.

47 Abram Lake
50 Agimak Lake
Allie Island (12 miles south of Kenora)
31 Barclay
48 Barrel Lake
"Big Pine Lake" = Wonderland Lake
Bishops Point (7 miles southeast of Kenora)
5 Black Sturgeon River
Blatzfiller's Island (near Kenora)
Blue Heron Island (Shoal Lake)
16 Bottle Bay
34 Brownridge Township, Kenora District
Cash Island (Shoal Lake)
19 Chadwick Lake
24 Clay Lake
Cliff Island (20 miles south of Kenora)
Cliff Lake (25 miles north of Vermilion Bay)
40 Contact Bay
37 Dinorwic
39 Dinorwic Lake
Dominique Island (Shoal Lake)
13 Dream Island (Lake of the Woods)
30 Dryden
17 Eagle Pass
28 Eagle River
Echlin's Island (near Kenora)
Felix Island (Shoal Lake)
Ferrier Island (14 miles SSE of Kenora)
Five Islands (Shoal Lake)
Gaherty Island (9 miles south of Kenora)
Galt Island (Shoal Lake)
Garden Island (Shoal Lake)
23 Gordon Lake
36 Hartman Township, Kenora District
20 Hawk Lake
9 High Lake
44 Hudson
49 Ignace
10 Indian Bay
Ingolf (see map near No. 3)
7 Keewatin
12 Labyrinth Bay (Shoal Lake Narrows)
53 Lac des Mille Lacs
6 Lac Lu
35 Laval Township, Kenora District
Longbow Lake (about 2 miles E of Kenora)
Long Pine Lake (Ingolf)
Macara Lake (Ingolf)
3 Malachi Lake
43 Manitou Lakes
41 Mile Lake
14 Miles Bay
2 Minaki
Norman (between Kenora and Keewatin)
45 Northpines
Oliver Island (13 miles S of Kenora)
29 Oxdrift
46 Pelican Lake
25 Perrault Lake, and Falls
Poplar Bay (6 miles SW of Kenora)
26 Quibell
Rabbitt Lake ($1\frac{1}{2}$ miles NE of Kenora)
4 Redditt
18 Rushing River
52 Savanne River
54 Shebandowan Lake
11 Shoal Lake
12 Shoal Lake Narrows
Silver Fox Island (Shoal Lake)
Sioux Lookout (see map No. 46)
15 Sioux Narrows
38 Southworth Township, Kenora District
Storm Bay (9 miles SE of Kenora)
Sultana Island (6 miles SE Kenora)
Thompson Island (6 miles S of Kenora)
33 Thunder Lake
42 Trap Lake
51 Upsala
27 Vermilion Bay
32 Wabigoon Lake
1 Whitedog Rapids
21 Willard Lake
22 Wonderland Lake

TRANSACTIONS

OF THE

Royal Canadian Institute

No. 63 | October, 1954 | Vol. XXX, Part II

191 COLLEGE STREET
TORONTO 2B, CANADA

Editorial Note: Series IIIA of the PROCEEDINGS OF THE ROYAL CANADIAN INSTITUTE was completed with the publication of Volume XVIII for the Session 1952–53.

THE DISTRIBUTION OF SOME TREES AND SHRUBS OF THE CAROLINIAN ZONE OF SOUTHERN ONTARIO[1]

PART III

W. SHERWOOD FOX[2] AND JAMES H. SOPER[3]

INTRODUCTION

IN PARTS I AND II of this series[4] the authors outlined in detail the distribution in Ontario of twenty-seven species of trees and shrubs characteristic of the Carolinian Zone, which is roughly that part of Ontario south of a line joining Grand Bend on Lake Huron and Toronto on Lake Ontario. In this paper similar data and maps are presented for a third and final group of fourteen species together with discussions and conclusions based on the complete group of forty-one species studied. The following are the species which make up the third group of trees and shrubs not previously discussed:

28.[5] *Carya cordiformis* (Wang.) K. Koch	JUGLANDACEAE
29. *Carya ovata* (Mill.) K. Koch	JUGLANDACEAE
30. *Carya laciniosa* (Michx.) Loud.	JUGLANDACEAE
31. *Carya tomentosa* Nutt.	JUGLANDACEAE
32. *Carya glabra* (Mill.) Sweet	JUGLANDACEAE
33. *Carya ovalis* (Wang.) Sarg.	JUGLANDACEAE
34. *Betula lenta* L.	CORYLACEAE
35. *Quercus alba* L.	FAGACEAE
36. *Quercus bicolor* Willd.	FAGACEAE
37. *Quercus Muehlenbergii* Engelm.	FAGACEAE
38. *Quercus prinoides* Willd.	FAGACEAE
39. *Quercus Prinus* L.	FAGACEAE
40. *Quercus palustris* Muenchh.	FAGACEAE
41. *Quercus velutina* Lam.	FAGACEAE

SYMBOLS AND ABBREVIATIONS

The same symbols have been used on the maps as in the two earlier papers of this series and these have been explained on page 68 of Part I. Similarly the same abbreviations for herbaria are employed here as listed on page 68 of Part I and page 4 of Part II. The following abbreviation is for a herbarium not pre-

[1]Manuscript received January 19, 1955.

[2]Former President of the University of Western Ontario, London.

[3]Assistant Professor of Botany and Curator of the Herbarium of Vascular Plants, University of Toronto, Toronto.

[4]Part I was published in the Transactions of the Royal Canadian Institute, Vol. XXIX, Part II, pp. 65–84, 1952, and Part II in the same publication, Vol. XXX, Part I, pp. 3–32, 1953.

[5]The numbers of the species discussed here begin at 28 and the numbers of the figures containing the maps to accompany these species begin at 26 in order to continue the arrangement used in Parts I and II of the series and to allow reference to the previous maps.

viously cited: A—Arnold Arboretum of Harvard University, Jamaica Plain, Massachusetts.

DISCUSSION OF SPECIES

JUGLANDACEAE—Walnut Family

In addition to the two species of *Juglans* (*J. cinerea* and *J. nigra*) discussed in Part II of this series, there is one other genus of this family native in Ontario. This is the genus *Carya*, represented here by six species of Hickory, all trees of the south (*Carya cordiformis*, *C. ovata*, *C. laciniosa*, *C. tomentosa*, *C. glabra*, and *C. ovalis*). Their distribution in the province is not uniform and the differences in this respect seem to indicate different degrees of hardiness. Two species are hardy enough to endure the winters of the upper St. Lawrence and the lower Ottawa: the Bitternut (*C. cordiformis*) and the Shagbark (*C. ovata*). In Ontario their northern limit is roughly 45° 30′ while the other four species are confined to the Lake Erie region and do not occur north of 43° 30′ north latitude. The distribution of each of the Hickories is outlined separately in the following paragraphs.

28. *Carya cordiformis* (Wang.) K. Koch—BITTERNUT, SWAMP HICKORY.

The distribution of the Bitternut in Ontario is shown in Fig. 26, and the following records include a selection of the specimens examined:

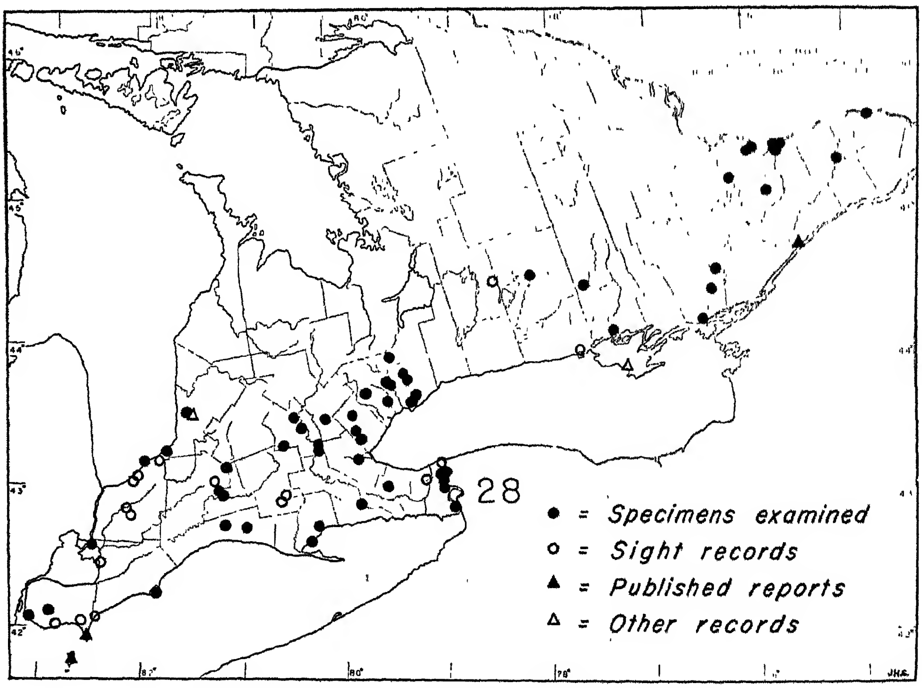

FIG. 26. Distribution of Bitternut (*Carya cordiformis*).

CARLETON: on shallow limestone, Harwood Plains, March Tp., Sept. 25, 1947, *Dore & Breitung 47–1254* (DAO); roadside in open, Ottawa West, Aug. 30, 1943, *M. N. Zinck 1309* (DAO); edge of field, lot 7, conc. IX, Marlborough Tp., July 2, 1946, *J. H. Soper et al. 3367* (DAO). ELGIN: St. Thomas, Aug. 5, 1941, *D. Young* (TRT); rich woods, Aylmer, June 1, 1898, *R. T. Anderson* (TRT). ESSEX: in old field, 5 miles southeast of Amherstburg, July 23, 1948, *W. G. Dore 8755* (DAO); low open woods southwest of Essex, June 17, 1953, *J. K. Shields 1317* (TRT); lot 13, conc. II, Mersea Tp., June 7, 1953, *J. K. Shields* (s.r. JHS); Cedar Creek, southwest of Kingsville, June 10, 1953, *J. K. Shields* (s.r. JHS); at Point Pelee and on Pelee Island—Dodge (7). FRONTENAC: Battersea, Aug. 21, 1903, *ex herb. J. Fowler* (QU); Loboro, June 5, 1886, *W. Nicol* (QU). GRENVILLE: near Prescott—Billings (1). HALDIMAND: Cayuga, Sept. ——, *Dr. Cowdry* (TRT). HALTON: edge of rocky woods, Mt. Nemo, May 24, 1952, *J. H. Soper et al. 5423* (TRT). HASTINGS: in rich low woods, vicinity of Belleville, June 10, 1868, *J. Macoun* (CAN); mixed woods and open overgrazed pasture east of Marmora, June 26, 1952, *Gillett & Calder 6263* (DAO). HURON: edge of ravine along creek, northwest of Varna on the Bayfield River, Aug. 9, 1941, *J. H. Soper s.n.* (TRT). KENT: rich woods, Rondeau Park, Aug. 15, 1934, *R. F. Cain 1154* (TRT); woods about one mile southeast of Wheatley, Aug. 3, 1950, *J. H. Soper* (s.r.). LAMBTON: sandy soil, Kettle Point, Aug. 10, 1941, *J. H. Soper 2826* (TRT); sandy field about 2 miles north of Lake Smith, July 18, 1950, *J. H. Soper et al. 2198* (DAO, McM); along roadside near the south end ferry, Walpole Is., Aug. 4, 1950, *Soper & Shields 5110* (TRT); lot 17, conc. XIV, Plympton Tp. & lot 15, conc. VII, Enniskillen Tp., Aug. 10, 1941, *J. H. Soper* (s.r.); lot 13, conc. X, Enniskillen Tp., Aug. 11, 1941, *J. H. Soper* (s.r.); abundant in Pinery from Grand Bend to Port Franks and border of Thedford celery beds, *W. S. Fox* (s.r.). LANARK: Ramsay Tp., 1862, *J. K. McMorine* (QU). LEEDS: wooded point, northwest shore of Lake Opinicon near Chaffey Locks, Aug. 23, 1945, *J. H. Soper et al. 2988* (DAO). LINCOLN: 3 miles southwest of Smithville, May 19, 1952, *Bert Miller 110* (McM); one mile southeast of St. Davids, Oct. 15, 1952, *Bert Miller 805* (McM); woods about 2 miles south of St. Catharines, June 18, 1950, *J. H. Soper* (s.r.); along Three-Mile Creek near Niagara-on-the-Lake, Aug. 12, 1952, *J. H. Soper* (s.r.). MIDDLESEX: river bank [Thames R.] at the Cove, London, May 19, 1880, *T. J. W. Burgess* (McG); edge of woods 3 miles southeast of Granton, July 20, 1950, *J. K. Shields 163* (TRT); along Highway No. 4, between concessions X and XI in London Tp., *W. S. Fox* (s.r.). NORFOLK: mixed woods, Turkey Point, May 21, 1933, *T. M. C. Taylor 6074* (TRT); southwest slope of ravine northwest of Port Ryerse, July 13, 1950, *J. H. Soper 2086* (DAO). NORTHUMBERLAND: open woods one mile east of Brighton, Oct. 10, 1949, *M. Heimburger* (s.r. JHS). PEEL: Snelgrove, Sept. 16, 1914, *J. H. White* (FFT). PETERBOROUGH: on limestone one mile south of Burleigh Falls, Aug. 2, 1951, *C. & M. Heimburger* (s.r. JHS). PRESCOTT: 4 miles west of l'Orignal, July 28, 1940, *H. A. Senn 1621, 1622* (DAO). PRINCE EDWARD: beside the road near Outlet, Sept. 4, 1954, *C. & M. Heimburger* (s.r. JHS). RUSSELL: Nation River at Casselman, Sept. 13, 1911, *J. Macoun* (CAN). VICTORIA: rocky soil, Bobcaygeon, June 6, 1952, *M. D. Kirk* (s.r. JHS). WATERLOO: low river flats on the Nith River south of Haysville, July 6, 1941, *J. H. Soper 2677* (TRT); flats of Conestoga River near St. Jacobs, May 9, 1942, *F. H. Montgomery 955* (DAO, McM, OAC). WELLAND: the Glen, Niagara River, July 2, 1898, *C. H. Armstrong* (TRT); along creek, lot 14, conc. V, Bertie Tp., May 27, 1950, *Bert Miller 17* (McM). WELLINGTON: swamps, Guelph, June 29, 1932, *W. H. Minshall 1603* (OAC). WENTWORTH: area D, Royal Botanical Garden, June 25, 1932, *H. A. Senn* (McM). YORK: Toronto, May 14, 1895, *M. Wilkes* (TRT); in field at edge of woods, Pottageville, July 1, 1934, *T. M. C. Taylor* (TRT); near Elder Mills, July 4, 1946, *R. Sims 216* (DAO); on dry slope, Maple, July 13, 1952, *M. Heimburger 670* (TRT).

29. *Carya ovata* (Mill.) K. Koch—SHAGBARK HICKORY.

The distribution of the Shagbark is shown in Fig. 27, and the following records include a selection of the specimens examined:

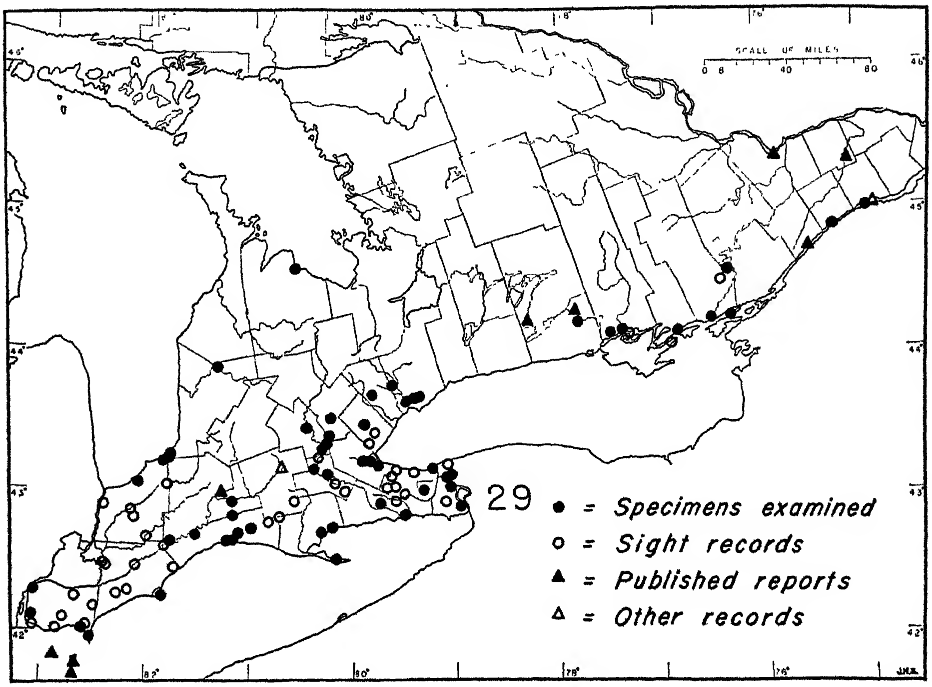

FIG. 27. Distribution of Shagbark Hickory (*Carya ovata*).

BRANT: damp woods, Paris, Aug. 20, 1932, *W. H. Minshall 6130* (OAC); lot 6, conc. IV, Tuscarora Tp., July 27, 1941, *J. H. Soper* (s.r.); lot 15, conc. IV, Dumfries S. Tp., Aug. 6, 1950, *J. H. Soper* (s.r.); lot 27, conc. V, Tuscarora Tp., May 28, 1950, *J. H. Soper* (s.r.). CARLETON: at Deschenes Rapids on the Ottawa (*Fletcher*)—Macoun (12), but no specimens seen from that locality. DUNDAS: in pasture lining creek along the St. Lawrence River 2 miles east of Iroquois, Aug. 13, 1953, *Dore & Gillett 14649* (DAO). ELGIN: rich woods about 3 miles southeast of Union, July 18, 1941, *J. H. Soper 2715, 2720* (TRT); 4 miles north of Dutton, July 22, 1948, *Soper & Dale s.n.* (TRT); lot 15, conc. IX, Bayham Tp., May 29, 1950, *J. H. Soper* (s.r.). ESSEX: oak-hickory woods near Amherstburg, July 27, 1948, *Soper & Dale 4084* (TRT); roadside southeast of Leamington, June 7, 1953, *J. K. & M. E. Shields 1150* (TRT); open woods, Windsor, Sept. 16, 1884, *J. M. Macoun* (CAN); 4 miles northwest of Kingsville, June 27, 1953, *J. K. Shields* (s.r. JHS); 2 miles east of Leamington, June 7, 1953, *J. K. Shields* (s.r. JHS); 4 miles northeast of South Woodslee, June 9, 1953, *J. K. Shields* (s.r. JHS); Cedar Creek, southwest of Kingsville, June 10, 1953, *J. K. Shields* (s.r. JHS); 3 miles southeast of Harrow, June 12, 1953, *J. K. Shields* (s.r. JHS); 5 miles north of Wheatley, June 19, 1953, *J. K. Shields* (s.r. JHS); Pelee Is., Middle Is., and East Sister Is.—Core (6). FRONTENAC: rich woods, Kingston, June 16, 1879, *D. Murray* (DAO, McG, TRT); Howe Is., St. Lawrence River, Sept. 6, 1954, *M. L. Heimburger 1674* (TRT); Lower Rock Lake, June 22, 1952, *J. H. Soper* (s.r.). GRENVILLE: near Prescott—Billing (1). GREY: in a farmer's field east of Meaford, Aug. 11, 1952, *J. H. Soper 5778* (TRT). HALDIMAND: north end of Low Banks, May 29, 1948, *Soper & Dale s.n.* (TRT); 3 miles south of Canfield, June 1, 1951, *Bert Miller 196* (McM); lot 21, conc. I, Moulton Tp., June 17, 1950, *J. H. Soper* (s.r.). HALTON: Milton, June 2, 1929, *H. H. Brown* (TRT); near Palermo, May 25, 1950, *J. H. Soper* (s.r.). HASTINGS: rocky banks, Belleville, July 27, 1877, *J. Macoun* (CAN); Ox Point, Thurlow Tp., June 14, 1950, *J. H. Soper*

(s.r.). HURON: woods and open places, Wingham, June, 1890, *J. A. Morton* (WO). KENT: Rondeau Park, June 17, 1953, *R. D. Ussher 103* (TRT); lot 13, conc. XII & lot 14, conc. XIII, Dover E. Tp., Aug. 11, 1941, *J. H. Soper* (s.r.); lot 18, conc. II, Harwich Tp., Aug. 12, 1941, *J. H. Soper* (s.r.); lot 4, conc. VIII, Raleigh Tp., July 31, 1953, *L. Stock* (s.r. JHS). LAMBTON: sandy field about 2 miles north of Lake Smith, July 18, 1940, *J. H. Soper et al. 2197* (DAO, McM); sandy soil along highway No. 21 at "The Cut" about 2 miles southeast of Port Franks, Aug. 10, 1941, *J. H. Soper 2824* (TRT); beech-maple woods about 2 miles north of Aberarder, Sept. 29, 1952, *M. L. Heimburger 975* (TRT); Carunna, Moore Tp. and lot 15, conc. VII, Enniskillen Tp., Aug. 10, 1941, *J. H. Soper* (s.r.); lot 24, conc. XIV, Dawn Tp., Aug. 12, 1941, *J. H. Soper* (s.r.); Arkona Rock Glen, Aug. 6, 1950, *J. H. Soper* (s.r.); roadside near Petrolia, Sept. 17, 1953, *J. H. Soper* (s.r). LEEDS: oak-hickory woods, Lake Opinicon, July, 1952, *J. K. Shields s.n.* (TRT). LENNOX & ADDINGTON: along highway No. 33 near Bath, Sept. 4, 1954, *M. L. Heimburger 1447* (TRT). LINCOLN: St. Davids, May 24, 1904, *Wm. Scott* (TRT); 2 miles west of Port Dalhousie, May 23, 1952, *Bert Miller 178* (McM, TRT); Niagara-on-the-Lake, July 25, 1941, *J. H. Soper* (s.r.); lot 39, conc. VI, Gainsborough Tp., June 17, 1950, *J. H. Soper* (s.r.); lot 19, conc. VII, S. Grimsby Tp., June 19, 1950, *J. H. Soper* (s.r.); near Grimsby, May 16, 1950, *J. H. Soper* (s.r.); lot 1, conc. V, Clinton Tp., May 17, 1950, *J. H. Soper* (s.r.); lot 11, conc. IV, Caistor Tp., Aug. 13, 1952, *J. H. Soper* (s.r.). MIDDLESEX: swampy ground, Westminster Ponds, London, July 1, 1879, *T. J. W. Burgess* (TRT); Wardsville, June 5, 1893, *N. D. Keith* (McG); 2 miles northeast of London—Saunders (71). NORFOLK: Fisher's Glen, May 20, 1951, *M. Landon* (ML); lakeshore, Woodhouse Tp., June 4, 1950, *M. Landon* (McM); Keeper's Ridge, Long Point, Aug. 18, 1951, *Falls & Klawe 768* (TRT). NORTHUMBERLAND: Meyersburg, Aug. 17, 1932, *H. H. Brown* (TRT); 4 miles above Campbellford on the Trent River—Macoun (12). OXFORD: lot 7, conc. XII, Dereham Tp., June 26, 1950, *J. H. Soper* (s.r.); lot 7, conc. VI, N. Norwich Tp., June 29, 1953, *L. Stock* (s.r. JHS); near Innerkip, Aug. 1, 1938, *Mrs. Davis* (s.r. J. K. Shields). PEEL: Snelgrove, Sept. 16, 1914, *J. H. White* (FFT). PETERBOROUGH: about the small lakes of the Otonabee—Traill (73). PRINCE EDWARD: between Cressy and Pleasant Point, Sept. 4, 1949, *C. & M. Heimburger* (s.r. JHS). RUSSELL: on the bank of the Nation River at Casselman—Macoun (12). STORMONT: open pasture, Wagner's Is., St. Lawrence River, Aug. 26, 1953, *J. M. Gillett 8030* (DAO); Sheek Is., 1953, *W. G. Dore* (corr. JHS). WATERLOO: slopes of Grand River below Galt, Sept. 5 & Oct. 13, 1940, *F. H. Montgomery 566* (McM, DAO); dry sandy slope of Grand River below Bridgeport, Sept. 6, 1942, *F. H. Montgomery 954* (DAO, McM, OAC). WELLAND: rich mesophytic stand near Effingham, June 27, 1941, *J. H. Soper 2645* (TRT); Niagara Falls, July 5, 1898, *Wm. Scott* (TRT); Carpenter's Woods, Fonthill, May 8, 1942, *W. F. Ainger 20* (McM); clay soil, lot 12, conc. VI, Bertie Tp., May 26 & Oct. 5, 1950, *Bert Miller 11 & 183* (McM); near Snyder, May 21, 1950, *J. H. Soper* (s.r.). WELLINGTON: gravelly ridges, Puslinch Lake, June 26, 1944, *W. G. Evans* (OAC); rich woods, Guelph, June 3, 1937, *J. J. Stroud* (TRT). WENTWORTH: low damp meadow south-west of Stoney Creek railway station, July 30, 1940, *Soper & McCallum 2292* (DAO, McM); edge of limestone escarpment, Hamilton, July 24, 1941, *J. H. Soper 2765* (TRT). YORK: 3 miles northeast of Clairville, June 11, 1946, *W. J. Cody 217* (DAO); rich woods, Deer Park Ravine, Toronto, May 31, 1935, *M. D. Kirk* (MDK); old Upper Canada College grounds [Toronto], May 22, 1894, *M. Wilkes* (TRT).

30. *Carya laciniosa* (Michx. f.) Loud.—KINGNUT, BIG SHELLBARK.

The territory in which the Kingnut and the Blue Ash (*Fraxinus quadrangulata*) are native in North America is a sort of pocket that lies between the southern end of the Great Lakes and the northwestern edge of the Carolinas. Both species enter Canada only in the region along the north shore of Lake Erie. The distinctive feature of *Carya laciniosa* which gives it the name of Kingnut is the

immense size of its fruit, a single one being almost as large as a Black Walnut fruit.

The Kingnut is rather rare in southern Ontario and the few specimens now surviving are widely scattered. The requirements of certain wood-working industries have greatly reduced the numbers of this never very abundant species. The records have been plotted on map 30, Fig. 28, and are listed below:

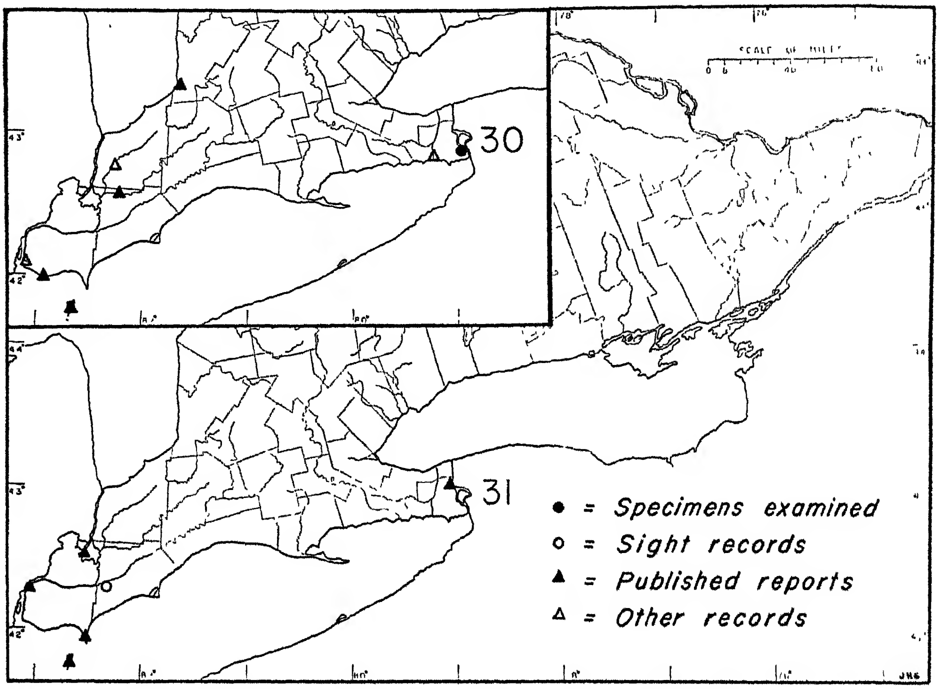

FIG. 28. Map 30: Distribution of Kingnut (*Carya laciniosa*).
Map 31: Distribution of Mockernut (*Carya tomentosa*).

ESSEX: rich soil, Pelee Is.—Core (6); near Colchester—Dodge (7); Amherstburg, *G. H. Smith* (corr. WSF). HURON: in the intervale lands of the Maitland, Bayfield and Aux Saubles Rivers—Gibson & Macoun (8). KENT: the northern part of Kent County—Dodge (20). LAMBTON: 2 miles west of Brigden, *Rumbold* (corr. WSF). WELLAND: sandy soil, Miller's Creek, Sept. 26, 1950, *Bert Miller 178* (McM); mouth of Miller's Creek, Oct. 9, 1948, *Bert Miller 880* (McM); along creek bank, lot 14, conc. V, Bertie Tp., *Bert Miller 16* (McM)—Mr. Miller reported that these three collections were made from a single tree (corr. JHS).

31. *Carya tomentosa* Nutt.—MOCKERNUT, WHITE-HEART HICKORY.

This species is confined to the Lake Erie region of Ontario as shown on map 31, Fig. 28. The records are rather few and are given below:

COUNTY NOT DETERMINED: shore of Lake Erie [without statement of definite locality], July 27, 1877, *J. Macoun* (OAC). ESSEX: Point Pelee and Pelee Island—Dodge (7); Windsor—Macoun (12). KENT: woods south of Prairie Siding, Aug. 3, 1950, *J. H. Soper*

(s.r.). LAMBTON: Squirrel Island—Dodge (54). WELLAND: in close proximity to Niagara Falls—Macoun (65).

32. *Carya glabra* (Mill.) Sweet—PIGNUT.

The Pignut is also confined to the Lake Erie region of Ontario and is usually met as scattered trees with the two common hickories (*C. cordiformis* and *C. ovata*). Its distribution is shown on map 32, Fig. 29, and the records follow:

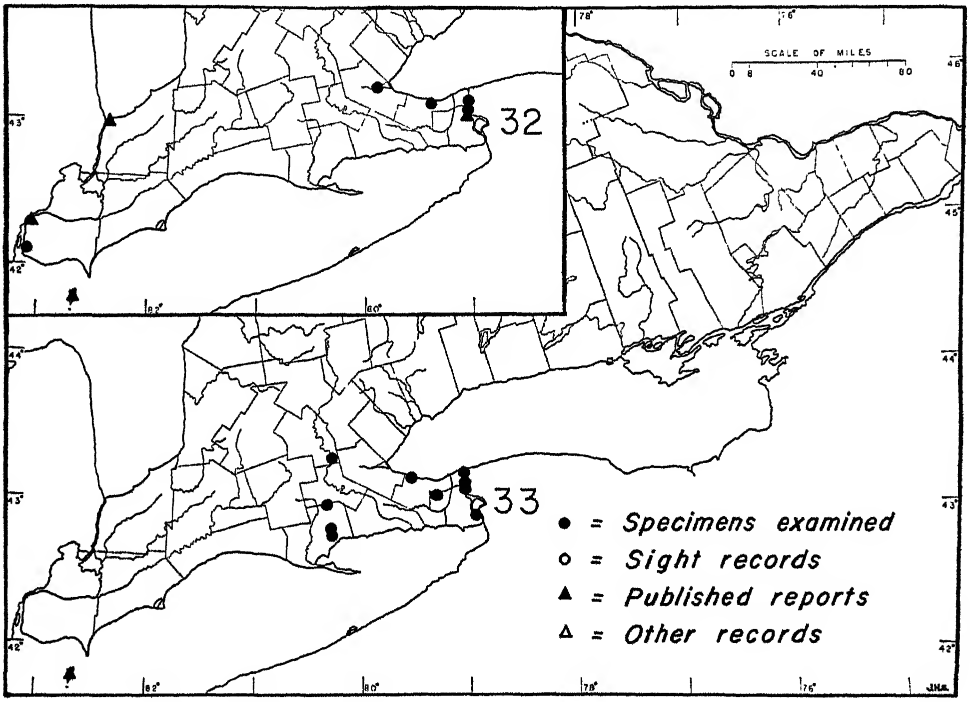

FIG. 29. Map 32: Distribution of Pignut (*Carya glabra*).
Map 33: Distribution of Red Hickory (*Carya ovalis*).

ESSEX: rich damp woods, Amherstburg, June 10, 1882, *J. Macoun* (CAN); Windsor—Macoun (12); Pelee Island—Core (6). LAMBTON: Sarnia—Macoun (12). LINCOLN: woods near Queenston Heights, May 26, Aug. 2, & Oct., 1897, *W. C. McCalla* (CAN, TRT); Vineland Station, June 1, 1940, *H. J. O'Reilly* (OAC). WELLAND: limestone ridge along top of river gorge, Niagara River between Queenston and Niagara Falls, July 30, 1940, *Soper & McCallum 2283* (DAO). WENTWORTH: Area C, Royal Botanical Garden [Hamilton: not dated, but probably 1932], *H. A. Senn* (McM).

33. *Carya ovalis* (Wang.) Sarg.—RED HICKORY, SWEET PIGNUT, FALSE SHAGBARK.

This species is restricted to the region between the Niagara and the St. Clair Rivers. It is a comparatively rare tree, although a few more collections have been seen than for the three preceding species. The records have been plotted on map 33, Fig. 29 and are listed below:

ESSEX: along north shore of Lake Erie and probably throughout Essex county, Pelee Island —Dodge (7). LAMBTON: occasional in dryish ground—Dodge (20), but no specific locality mentioned. LINCOLN: woods near Queenston Mountain, May 26, Aug. 2, & Oct., 1897, *W. C. McCalla* (TRT); Grimsby, Aug. 12, 1934, *Abram Bater* (TRT); Oak Grove, one mile south of Niagara-on-the-Lake, Aug. 20, 1949, *A. E. Straby* (OAC). NORFOLK: dry sandy woods about 4 miles northwest of Port Ryerse, July 13, 1940, *J. H. Soper 2094* (DAO, McM); lot 12, Gore of Woodhouse Tp., July 2, 1948, *M. Landon* (McM); lot 3, conc. I, Townsend Tp., July 25, 1948, *M. Landon* (ML). WATERLOO: slopes of Grand River below Galt, Sept. 5, & Oct. 13, 1940, *F. H. Montgomery 566* (DAO, McM). WELLAND: dry sandy soil southwest of Queenston, July 25, 1941, *J. H. Soper 2772* (TRT); mesophytic woods near Effingham, June 27, 1941, *J. H. Soper 2648* (TRT); Miller's Creek, Bertie Tp., Oct. 5, 1948, *Bert Miller 871* (McM).

CORYLACEAE—Hazel Family

34. *Betula lenta* L.—CHERRY BIRCH, SWEET BIRCH, BLACK BIRCH.

The existence of this tree in Ontario has been both assumed and disputed for many years, judging by published reports in manuals and local lists. The only authentic material which has been seen by the junior author is a single stand in the Niagara Peninsula near the south shore of Lake Ontario. The trees at this station have thick close dark bark becoming ridged and furrowed in age and not peeling in curly plates as in *Betula lutea* Michx. f., the Yellow or Gray Birch. They also possess the sweet aromatic bark, the doubly serrate leaf with a cordate base, the short-cylindric fruiting catkin with firm smooth scales. The chief point of confusion to those not familiar with both species has been the colour and closeness of the bark. In *B. lutea* it may be quite dark brown, almost black, particularly on the trunk at the base of old trees. This has been named *B. lutea* forma *fallax* by Fassett (58) who described this form as having the bark deep brown ("cortice brunneo"), scarcely loosening into layers or plates. Fassett noted that "This tree occurs in company with typical *B. lutea*, and differs from it only in having bark closely simulating that of *B. lenta*. Such individuals probably explain numerous sheets in the University herbarium misidentified as *B. lenta*, and perhaps forms the basis of reports of the Cherry Birch from this state" [Wisconsin].

The above statement may be applied equally well to Ontario for here also misidentifications have been found in many local herbaria and until two years ago not a single authentic specimen had been seen by the authors. Recently, a keenly observant naturalist, Mr. A. W. Miller of Fort Erie, has located one stand of *Betula lenta* in the Niagara district and the existence of this species in Ontario is at last demonstrated satisfactorily. The statements made about the North American range of the Black Birch by W. H. Blanchard (49) forty-three years ago are particularly appropriate to the confusion in our Ontario records of *Betula lenta*: "The provincial botanists having never seen the real black birch think that when they find a yellow birch (*B. lutea* L.) with black bark they have found a black birch, and lumbermen everywhere from the Adirondacks to New Brunswick are sure that they have two birches which they are loth to believe can be age variations only . . . In short, the two birches *B. lenta* and *B. lutea* have been so confounded by lumbermen and botanists that no dependence whatever can

be placed on any published statement as to either range or frequency of the black birch in the north, northeast or northwest".

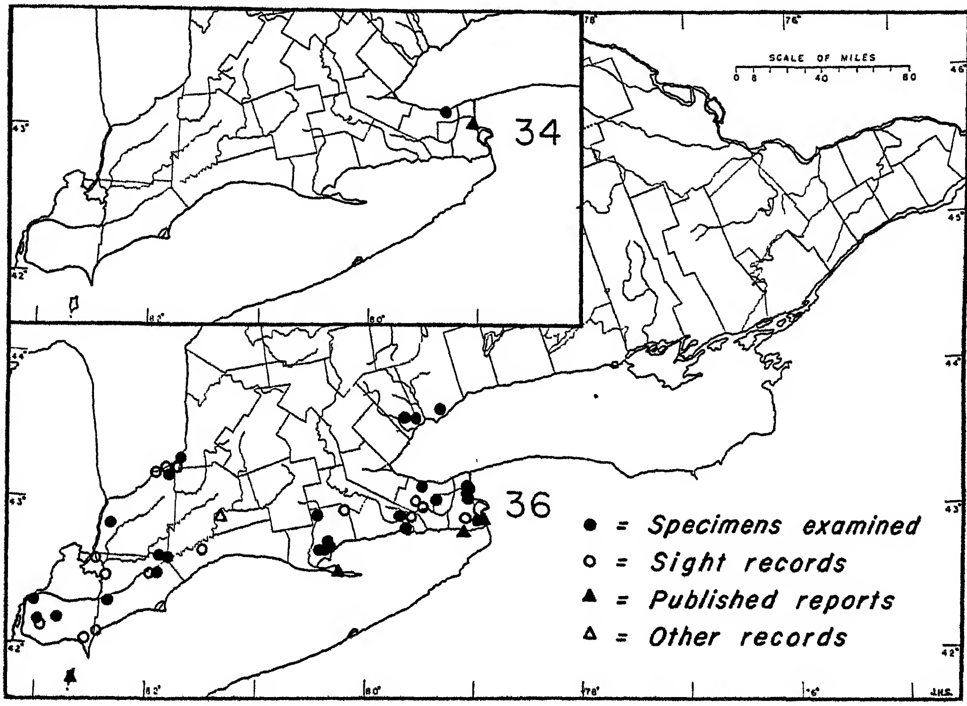

FIG. 30. Map 34: Distribution of Cherry Birch (*Betula lenta*).
Map 36: Distribution of Swamp White Oak (*Quercus bicolor*).

Map 34, Fig. 30, shows the location of the authentic station in the Niagara district together with a single literature record which is admitted because of its proximity to the other locality. All the other Ontario collections labelled *Betula lenta* have proved to be *B. lutea* and therefore all the literature records must be excluded with this one possible exception. The data are as follows:

LINCOLN: highland, 3 miles west of Port Dalhousie, Louth Tp., Sept. 24, 1953, *Bert Miller 797* (McM); edge of bank in woods along the shore of Lake Ontario about 3 miles west of Port Dalhousie, Aug. 19, 1954, *Soper & Dale 6060*[6] (TRT). WELLAND: in the Niagara Glen —Hamilton (26), but no specimens seen: it seems quite possible that other stands of *B. lenta* may be located in the region between Port Dalhousie and the Niagara River since this species occurs in western New York state.

By not accepting the other published reports for *Betula lenta* in Ontario we have excluded one which needs further comment. Blanchard, who obviously understood the differences between *B. lutea* and *B. lenta*, stated (loc. cit., p. 207): "Its range in the provinces of Quebec and Ontario I do not know, but it

[6]A duplicate of this collection was sent to Prof. W. M. Harlow of the New York State College of Forestry, Syracuse, and the identification confirmed.

is abundant at and about Ottawa." There is no indication as to whether Blanchard had seen specimens of Black Birch in or from the Ottawa district or whether he accepted the record and descriptive note published earlier by Fletcher (60). All the material from the Ottawa district examined by the junior author, however, seems to be *Betula lutea* nor has he been able to locate a botanist in that district who is aware of the existence of *B. lenta* in the vicinity of Ottawa. Marie-Victorin (67) reported *B. lenta* from the southwestern part of Quebec only, mentioning the valley of the Ottawa and the region around Montreal. It is possible that this species may be present in the Ottawa district or the easternmost counties of Ontario between the St. Lawrence and the Ottawa rivers. It is also possible that it definitely occurred in the Ottawa district and is now extinct there as appears to be the case with *Hamamelis virginiana*. In the absence of authentic specimens, however, it seems better to exclude the Ottawa records until verification is forthcoming.

FAGACEAE—Beech Family

This family is represented in southern Ontario by eleven native species of trees, the Beech (*Fagus grandifolia*), the Chestnut (*Castanea dentata*) and nine species of Oak. The Chestnut has already been discussed in Part II of this series. The Beech and two of the species of Oak, *Quercus macrocarpa* and *Quercus rubra* (including *Q. borealis*) are common in southern Ontario and range northward far beyond the limits of the area under discussion. For that reason they will not be included in the present paper. One additional species of Oak (*Q. coccinea*) is discussed although it is not believed to be native in Ontario.

The species of *Quercus* to be discussed may be grouped as follows:

I. THE WHITE OAKS (Subgenus *Lepidobalanus*)

Quercus alba
Q. bicolor
Q. Muehlenbergii
Q. prinoides
Q. Prinus

II. THE RED AND BLACK OAKS (Subgenus *Erythrobalanus*)

Q. palustris
Q. velutina
Q. coccinea

I. THE WHITE OAKS.—The chief features possessed in common by the members of this group are leaves with rounded teeth or lobes not having the veins protruding beyond the leaf margin as bristles, bark pale and often scaly or flaky, acorns maturing the first year and with the inner surface of the shell of the nut smooth.

35. *Quercus alba* L.—WHITE OAK.

In respect of distribution the White Oak and the Black Cherry are very comparable, both in their total North American area and in their extent in southern

Ontario. In general both trees are scattered over the territory to about the same degree of density but the Oak has perhaps more of a habit of forming large stands. In Ontario both have been greatly reduced in numbers by excessive cutting and most of the White Oak now used for lumber in this province is imported from the United States. Much of this is not *Quercus alba* but wood of other species of the White Oak group.

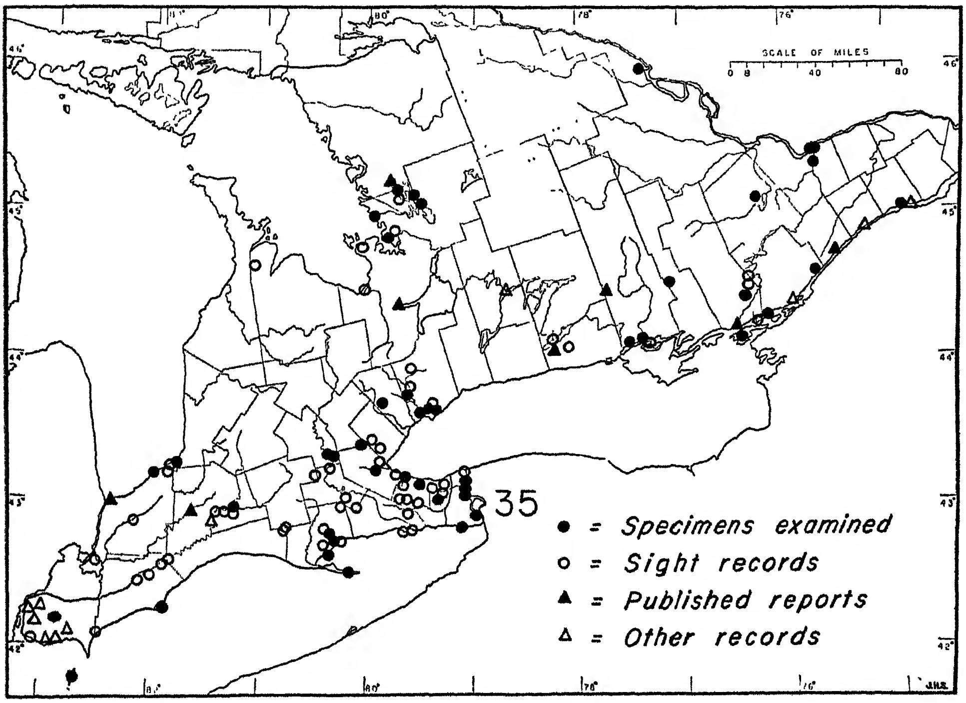

FIG. 31. Distribution of White Oak (*Quercus alba*).

The distribution of *Quercus alba* is shown in Fig. 31, and the following list includes most of the records used:

BRANT: lot 6, conc. IV, Tuscarora Tp., July 27, 1941, *J. H. Soper* (s.r.); lot 15, conc. IV, Dumfries S. Tp., June 26, 1950, *J. H. Soper* (s.r.). CARLETON: Ottawa, June 9, 1946, *A. J. Breitung 2490* (DAO); on sand banks, Merivale Sand Pits, June 9, 1947, *J. M. Gillett 1190* (DAO). DUNDAS: from Morrisburg to Cornwall along the St. Lawrence River—Dore (corr. JHS). ESSEX: edge of field in heavy soil, southwest of Essex, June 24, 1944, *W. G. Dore 44–13* (DAO); Pelee Island, June 11, 1911, *C. K. Dodge* (A); near Malden Centre, July 27, 1948, *J. H. Soper* (s.r.); Cedar Creek, Gosfield S. Tp., June 10, 1953, *J. K. Shields* (s.r.); near Harrow, June 11 & 12, 1953, *J. K. Shields* (s.r.); northeast of Amherstburg, June 22, 1953, *J. K. Shields* (s.r.); northwest of Kingsville, June 27, 1953, *J. K. Shields* (s.r.); lot 15, conc. VI & near La Salle, June 23, 1953, *J. K. Shields* (s.r.); an interesting note on the occurrence and size of this species in the Lake St. Clair and Detroit River regions was recorded by Douglas in his Journal (55) as follows: ". . . on the banks of the River Detroit, from Amherstburgh to the junction of the Thames with the St. Clair in Upper Canada, and on the opposite banks, in the Michigan Territory, on a deep alluvial rich black soil, these trees fre-

quently measure from 20 to 25 feet in circumference at 8 feet from the ground, and are from 80 to 100 feet high". FRONTENAC: Wolfe Is., June 25, 1881, *ex herb. J. Fowler* (QU); Battersea, May 28, 1904, *ex herb. J. Fowler* (QU); between Hart Lake and Lake Opinicon, June 19, 1952, *J. H. Soper* (s.r.); Howe Is., Sept. 6, 1954, *M. L. Heimburger* (s.r. JHS); near Kingston—Drummond (56). GRENVILLE: near Prescott—Billings (1). GREY: near Hepworth, June 9, 1952, *J. H. Soper* (s.r.). HALDIMAND: lot 12, conc. V, Dunn Tp., Aug. 2, 1941, *J. H. Soper* (s.r.); lot 21, conc. I, Moulton Tp., June 17, 1950, *J. H. Soper* (s.r.); lot 3, conc. II, Sherbrooke Tp., June 17, 1950, *J. H. Soper* (s.r.). HALTON: Mount Nemo, May 21, 1952, *J. H. Soper* (s.r.); Crawford Lake, Dec. 8, 1935, *W. K. W. Baldwin* (s.r. JHS). HASTINGS: vicinity of Belleville, May, 1878, *J. Macoun* (MT); on the limestone in deciduous woods—Gillett (61). HURON: common in Grand Bend, *W. S. Fox* (s.r.). KENT: sandy fields, Rondeau Park, Aug. 16, 1940, *J. H. Soper 2393* (DAO, McM); lot 18, conc. II, Harwich Tp., Aug. 12, 1941, *J. H. Soper* (s.r.); lot 6, conc. VIII, Zone Tp., June 25, 1950, *J. H. Soper* (s.r.); lot 10, River Range, Howard Tp., June 24–25, 1950, *J. H. Soper* (s.r.); near Wheatley, Aug. 3, 1950, *J. H. Soper* (s.r.). LAMBTON: sandy soil about 2 miles south of Grand Bend, July 17, 1940, *J. H. Soper et al. 2154* (DAO, McM); rich woods, Kettle Point, July 19, 1940, *L. O. Gaiser* (McM); lot 13, conc. X, Enniskillen Tp., Aug. 11, 1941, *J. H. Soper* (s.r.); near Port Franks, June 20, 1948, *J. H. Soper* (s.r.); Walpole Is., Aug. 4, 1950, *J. H. Soper* (s.r.); east of Point Edward—Dodge (54). LANARK: Ramsay, June, 1862, *J. K. McMorine* (QU). LEEDS: Forsyth Is., July ——, *R. Campbell* (McG); woods on the Precambrian, Brockville, Sept. 5, 1943, *Fr. Marie-Victorin et al. 56856* (DAO, MT, TRT); Lake Opinicon, June 17–18, 1952, *J. H. Soper* (s.r.); in rocky woods about one mile west of Rockport, Sept. 5, 1954, *C. & M. Heimburger* (s.r.). LENNOX & ADDINGTON: on the granite rock of the fire-barrens, 8 miles south of Kaladar, Aug. 15, 1949, *Dore & Frankton 10291* (DAO). LINCOLN: edge of wooded ravine, Beamsville, July 4, 1950, *Soper & Shields 4873* (TRT); 5 miles northwest of Grimsby, May 21, 1952, *Bert Miller 132* (McM); in woods, Queenston Heights, Sept. 12, 1896, *Wm. Scott* (CAN); lot 17, conc. III, N. Grimsby Tp., May 16, 1950, *J. H. Soper* (s.r.); near DeCew Falls, May 22, 1950, *J. H. Soper* (s.r.); lot 39, conc. VI, Gainsborough Tp., June 17, 1950, *J. H. Soper* (s.r.); lot 19, conc. VII, S. Grimsby Tp., June 19, 1950, *J. H. Soper* (s.r.); lot 19, conc. III, Louth Tp., July 4, 1950, *J. H. Soper* (s.r.); lot 1, conc. VI, Clinton Tp., May 29, 1951, *J. H. Soper* (s.r.); Three-Mile Creek near Niagara-on-the-Lake, Aug. 12, 1952, *J. H. Soper* (s.r.); lot 11, conc. IV, Caistor Tp. and near Bismarck, Aug. 13, 1952, *J. H. Soper* (s.r.). MIDDLESEX: in wood, London, Aug. 9 & Oct. 4, 1881, *T. J. W. Burgess* (TRT); lot 24, conc. II, Mosa Tp. & lot 21, conc. I, Westminster Tp., Aug. 12, 1941, *J. H. Soper* (s.r.); lot 25, conc. I, London Tp. & lot 10, conc. I, Lobo Tp., June 24, 1950, *J. H. Soper* (s.r.); about a mile east of Strathroy—Greene (62); near Mt. Brydges, July 19, 1950, *J. K. Shields* (s.r.). MUSKOKA: among rocks, Moore Pt., Honey Harbour, July 29, 1934, *T. M. C. Taylor* (TRT); on rocks, Go Home, July 29, 1904, *A. G. Huntsman* (CAN); [Lake Joseph] Muskoka, [without date], *R. W. Smith* (McM); on high ground, Milford Bay, June 25, 1942, *W. H. Minshall 3162* (DAO); rocky woods, Port Carling, July 11, 1939, *L. C. Coleman* (TRT); north of Port Severn, Aug. 8, 1952, *M. L. Heimburger* (s.r. JHS); lot 24, conc. VIII, Baxter Tp., July 23, 1952, *J. H. Soper* (s.r.); Bass Lake, Medora Tp., July 24, 1952, *J. H. Soper* (s.r.). NORFOLK: wooded cliff along shore, Turkey Point, Sept. 17, 1938, *J. H. Soper 748* (McM); south beach, 11 miles west of lighthouse, Long Point, *Falls & Klawe 455* (TRT); dry loamy soil about 4 miles northwest of Port Ryerse, July 13, 1940, *J. H. Soper 2090* (DAO, GH, McM); lot 1, conc. I, Woodhouse Tp., July 13, 1940, *J. H. Soper* (s.r.); lot 14, conc. IV, Charlotteville Tp., June 25, 1941, *J. H. Soper* (s.r.); lot 22, conc. II, Townsend Tp., July 27, 1941, *J. H. Soper* (s.r.); south of Tillsonburg in Middleton Tp., June 11, 1953, *J. H. Soper* (s.r). NORTHUMBERLAND: lot 22, conc. VII, Haldimand Tp., Aug. 13, 1948, *J. H. Soper* (s.r); on the high plateau of land east of the Rice Lake plains—Traill (73). OXFORD: lot 3, conc. XII, Dereham Tp., May 29, 1950, *J. H. Soper* (s.r.); lot 2, conc. V, Blenheim Tp., June 23, 1950, *J. H. Soper* (s.r.). PARRY SOUND: the island of Hunto in Portage Lake, 20 miles southeast of Parry Sound—Sinclair (72). PEEL: Snelgrove, 1919, *J. White* (FFT). PETERBOROUGH: mouth of the Otonabee River, June

12, 1948, *J. H. Soper* (s.r.). PRINCE EDWARD: lot 53, conc. II, Ameliasburgh Tp., Aug. 4, 1951, *J. H. Soper* (s.r). RENFREW: stony shore, Highview, Chalk River, Aug. 21, 1946, *I. Hustich* (CAN). SIMCOE: near mouth of Nottawasaga River, June 29, 1950, *J. H. Soper* (s.r.); Thunder Beach, Tiny Tp., Aug. 9, 1952, *J. H. Soper* (s.r.); vicinity of Barrie—Spotton (41). STORMONT: on open area of Sheek Is., St. Lawrence River, July 12, 1941, *W. H. Minshall 2436* (DAO); from Cornwall to Morrisburg along the St. Lawrence River—Dore (corr. JHS). VICTORIA: Sturgeon Point, June 6, 1953, report of Peterborough Nature Club in Nature News, June 1953. WATERLOO: field margin 2 miles west of Galt near Roseville, Aug. 30, 1950, *C. Frankton 1270* (DAO, MT); dry woods, Victoria Park, Galt, Aug. 4, 1941, *F. H. Montgomery 846* (DAO, McM, OAC). WELLAND: Carpenter's Woods, Fonthill, Aug. 14, 1942, *W. F. Ainger* (McM); highland over limestone, lot 9, conc. VII, Bertie Tp., May 26, 1950, *Bert Miller 12* (McM); sandy soil, Point Abino, Sept. 18, 1950, *Bert Miller 142* (McM); gravelly soil along Niagara River between Niagara Falls and Queenston, July 30, 1940, *Soper & McCallum 2280* (DAO, McM). WENTWORTH: Hamilton, May 22, 1935, *Claire Morin* (MT); wet ground in woods, conc. XII, E. Flamborough Tp., May 11, 1941, *L. O. Gaiser* (McM); lot 14, conc. I, Saltfleet Tp., July 24, 1941, *J. H. Soper* (s.r.); lot 20, conc. IV, Barton Tp., July 24, 1941, *J. H. Soper* (s.r.); lot 5, conc. II, Flamborough E. Tp. & lot 20, conc. II, Flamborough W. Tp., June 16, 1950, *J. H. Soper* (s.r.). YORK: dry woods, Toronto, May 24, 1941, *D. W. Kirk* (MDK); Woodbridge, Oct. 26, 1935, *H. H. Brown* (TRT); lot 22, conc. VI, Vaughan Tp., Aug. 4, 1948, *J. H. Soper* (s.r.); lot 18, conc. VI, King Tp., June 28, 1950, *J. H. Soper* (s.r.); Don Valley at Lawrence Avenue, Toronto, May 22, 1951, *J. H. Soper* (s.r.).

36. *Quercus bicolor* Willd.—SWAMP WHITE OAK.

This oak, like the Pin Oak, is native only in the northern half of the international territory occupied by such representative Carolinians as the Flowering Dogwood and Sassafras. In Ontario, however, it appears to be hardier than the Pin Oak, extending throughout the Carolinian region and possibly beyond in a few isolated places north of Lake Ontario. The form of the Swamp White Oak leaf is somewhat intermediate between leaves of the true White Oak and those of certain of the Chestnut Oaks. In some of the eastern counties of Ontario certain specimens of Bur Oak (*Q. macrocarpa*) possess leaves with rather shallow regular lobing and hairy undersurfaces. These two facts have given rise to some errors in identification which have affected statements of the distribution of this species in Ontario.

Map 36, Fig. 30, shows what is believed to be an accurate picture of the range of Swamp White Oak in Ontario but verification of the two excluded records noted below would remove this species from the group restricted to the Carolinian region of Ontario. The records are as follows:

ELGIN: lot 20, conc. IV, Dunwich Tp., July 22, 1948, *J. H. Soper* (s.r.). ESSEX: *Carex* swamp near the Canard River, 5 miles northeast of Amherstburg, June 22, 1953, *J. K. Shields 1371* (TRT); edge of field in heavy soil, southwest of Essex, June 24, 1944, *W. G. Dore 44–11* (DAO); low ground, Windsor, Sept. 16, 1884, *J. M. Macoun* (CAN); 3 miles east of Leamington, June 7, 1953, *J. K. Shields* (s.r. JHS); Pelee Is.—Core (6). HALDIMAND: highland one mile southwest of Darling Road, June 1, 1951, *Bert Miller 199* (McM); Byng, Oct. 1913, *ex herb. J. F. Cowell* (A); lot 21, conc. I, Moulton Tp., June 17, 1950, *J. H. Soper* (s.r.). KENT: sandy soil between Highgate and Thamesville, Aug. 16, 1940, *J. H. Soper et al. 2412* (DAO, GH, McM); along bank of Jeannette Creek about one mile south of Prairie Siding, Aug. 3, 1950, *Soper & Shields 5070* (TRT); E. Bothwell, Aug. 16, 1934, *R. F. Cain* (TRT); lot 13, conc. XII, Dover E. Tp., Aug. 11, 1941, *J. H. Soper* (s.r.); lot 10, River

Range, Howard Tp., June 24–25, 1950, *J. H. Soper* (s.r.); woods about one mile southeast of Wheatley, Aug. 3, 1950, *J. H. Soper* (s.r). LAMBTON: [near] Grand Bend, Aug. 22, 1932, *H. H. Brown* (TRT); Lake Smith, [near] Thedford, Oct. 13, 1936, *W. S. Fox* (WO); low ground Moore Tp., Aug. 20, 1897, *A. E. Gurd* (WO); north end of Walpole Is., Aug. 4, 1950, *J. H. Soper* (s.r.). LINCOLN: Beamsville, June 30, 1929, *H. H. Brown* (TRT); in woods, Queenston Heights, July 9, 1896, *Wm. Scott* (TRT); lot 39, conc. VI, Gainsborough Tp., June 17, 1950, *J. H. Soper* (s.r.); near Bismarck, Aug. 13, 1952, *J. H. Soper* (s.r.). MIDDLESEX: low woods near Cashmere, Aug. 12, 1941, *J. H. Soper 2833* (TRT); conc. III, along Dingman Creek, Delaware Tp., July 27, 1950, *J. K. Shields* (s.r.). NORFOLK: roadside, Walsh P.O., June 5, 1938, *H. H. Brown* (TRT); woodlot northeast of St. Williams, Sept. 3, 1950, *M. L. Heimburger* (TRT); moist deciduous woods, lot 15, conc. VII, Charlotteville Tp., Aug. 30, 1950, *M. Landon* (McM, ML); lot 17, conc. X, Windham Tp., Nov. 20, 1948, *M. Landon* (McM); lot 22, conc. II, Townsend Tp., July 27, 1941, *J. H. Soper* (s.r.); Long Point—Synder (40). PEEL: Summerville, July 9, 1932, *H. H. Brown* (TRT); Britannia, May 30, 1936, *H. H. Brown* (TRT). WELLAND: gravelly ridges along top of gorge of Niagara River between Queenston and Niagara Falls, July 30, 1940, *Soper & McCallum 2285* (DAO, GH, McM); low woods, lot 13, conc. I, Pelham Tp., June 22, 1941, *J. H. Soper 2615* (DAO, TRT); highland, Miller's Creek East. Bertie Tp., Oct. 5, 1948, *Bert Miller 872* (McM); near Synder, May 21, 1950, *J. H. Soper* (s.r.); Fort Erie and along Lake Erie to Point Abino and beyond—Zenkert (14). YORK: Don Valley, Toronto, Oct. 4, 1930, *H. H. Brown* (TRT).

EXCLUDED RECORDS: HASTINGS & NORTHUMBERLAND: according to Macoun (12) *Quercus bicolor* occurred in . . . "that part of Ontario west of the Trent River. We have no authentic record of it east of the Moira, Hastings Co., Ont., but it is still met with in low, damp or swampy woods throughout the valley of the Trent" . . . One specimen has been seen labelled Hastings Co. (without a definite locality stated) collected by Prof. Macoun on Sept. 18, 1873 (McG) but it appears to be *Quercus alba.* No recent collections nor other reports for *Quercus bicolor* have been found for the Trent River district. RUSSELL: Casselman according to Fletcher (59), but no specimens nor other reports found for this district. Some other southern species are known in these two districts and it may be that the Swamp White Oak once occurred in both and is now extinct. Until more definite proof of its occurrence is forthcoming, however, these two records should perhaps be excluded. Botanists should be on the watch for this oak in both districts.

37. *Quercus Muehlenbergii* Engelm.—CHESTNUT OAK, YELLOW OAK.

There are three species in the White Oak group which may be called Chestnut Oaks. The name arises from the common character they share in having a leaf of which the outline is very much like that of the Sweet Chestnut, also a Carolinian tree of the Beech family. Since at some time or other this common name has been applied colloquially to every member of the group, it is often difficult to sort out the references in published works. Very few Canadians are even aware that such a tree as a Chestnut Oak is native to any part of their country.

This first species in the Chestnut Oak group, *Quercus Muehlenbergii*, seems to prefer soils that are basically calcareous. Several typical sites are on either sedimentary or metamorphic limestones, for example at the gorge or glen of the Aux Sables River at Arkona, along the Niagara Escarpment at Dundas, and along the brow of the Niagara gorge between Queenston and Niagara Falls. On this last site one may today see two arborescent species of Chestnut Oak as did David Douglas on his visit to the Niagara in 1823. Douglas noted (55) that several kinds of oaks there had serrated leaves, but he did not attempt to name

the kinds. One may say that, as a rule, the leaf of *Q. Muehlenbergii* tends to be quite sharply saw-toothed along the edges, with the teeth acute and pointing slightly towards the tip of the leaf. The teeth of the leaf of *Q. Prinus* are more uniformly rounded and not conspicuously directed towards the tip of the leaf. Both species grow side by side also in certain sandy areas in both Lambton and Norfolk counties.

In Ontario *Q. Muehlenbergii* is apparently more hardy than *Q. Prinus*, for in addition to the occurrence of both species in the Carolinian region, the former occurs also north of Lake Ontario from the Trent River valley to the upper St. Lawrence River and the upper Rideau Lakes system. The distribution of *Q. Muehlenbergii* is shown in Fig. 32, and the following list gives the records on which the map is based:

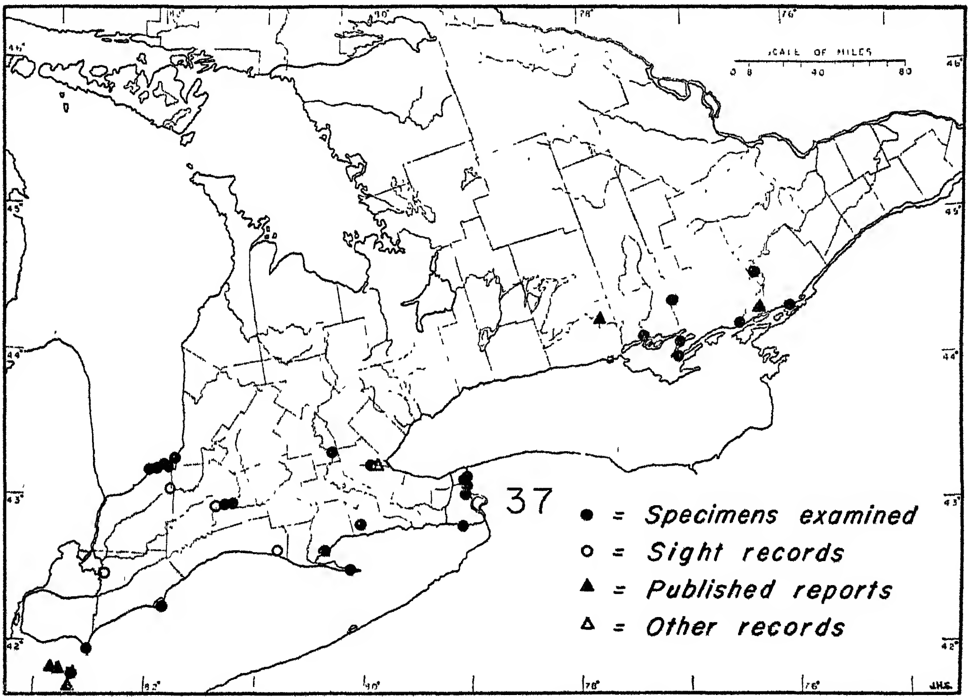

FIG. 32. Distribution of Chestnut Oak (*Quercus Muehlenbergii*).

ELGIN: woods along bank of Otter Creek near Vienna, May 28, 1950, *J. H. Soper* (s.r.). ESSEX: sand plain, Point Pelee, Aug. 31, 1950, *J. H. Soper 2490* (DAO, GH, McM); Pelee, Middle, Hen, and East Sister Islands—Core (6). FRONTENAC: Kingston, *M. Landon* (TRT); in the township of Pittsburg near Kingston (as *Quercus castanea*)—Drummond (57). HALDIMAND: soil over limestone, south of Sandusk, Oct. 3, 1951, *Bert Miller 680* (McM). HASTINGS: in rich woods, vicinity of Belleville, May & Aug. 1878, *J. Macoun* (CAN); along both sides of the Bay of Quinte in the neighbourhood of Belleville—Macoun (12). KENT: sandy soil, Rondeau Park, Aug. 15, 1940, *J. H. Soper 2370* (DAO, GH, McM); lot 13, conc. XII, Dover E. Tp., Aug. 11, 1941, *J. H. Soper* (s.r.). LAMBTON: sandy field, Port Franks, July 21, 1940, *J. H. Soper et al. 2265* (DAO, GH, McM); sandy field, Kettle

Point, July 21, 1940, *J. H. Soper et al. 2263* (DAO, GH, McM); on steep side of Aux Sables gorge at Arkona, 1946, *W. S. Fox* (s.r.). LEEDS: rocky hill near shore of Lake Opinicon, Aug. 22, 1945, *J. H. Soper et al. 2903* (DAO); rocky banks near the St. Lawrence River, Lansdowne, June 27, 1895, *C. J. Young* (CAN). LENNOX & ADDINGTON: northwest end of Lime Lake, southeast of Marlbank, Aug. 14, 1948, *Soper & Dale s.n.* (TRT); edge of woods at Watercombe, Aug. 6, 1951, *M. L. Heimburger 67* (TRT). LINCOLN: one mile southeast of St. Davids, Oct. 15, 1952, *Bert Miller 811* (McM); in woods, Queenston Heights, June 29, 1896, *Wm. Scott* (TRT). MIDDLESEX: London, June, 22, 1934, *M. L. Fernald* (GH); field, Byron, Oct. 1937, *W. G. Colgrove* (WO); lot 10, conc. I, Lobo Tp., June 24, 1950, *J. H. Soper* (s.r.). NORFOLK: sandy woods, Turkey Point, May 20, 1933, *T. M. C. Taylor* (TRT); sandy ridge, deciduous woods, Long Point, July 28, 1951, *Falls & Klawe 650* (TRT). NORTHUMBERLAND: along the Trent at Campbellford Bridge—Macoun (12). PRINCE EDWARD: in woods at top of steep slope opposite Lake-on-the-Mountain resort, Oct. 9, 1949, *M. L. Heimburger* (TRT). WATERLOO: Galt, May 24 & Oct. 16, 1902, *W. Herriot* (OAC). WELLAND: gravelly limestone ridge along edge of river gorge, Niagara River between Queenston and Niagara Falls, July 30, 1940, *Soper & McCallum 2284* (DAO, GH, McM); sand over limestone, Point Abino, May 30, 1950, *Bert Miller 26* (McM, TRT). WENTWORTH: Dundas, May 24 & July 1, 1902, *W. Herriot* (OAC); on the side of a ravine east of the headquarters of the Royal Botanical Gardens, Hamilton—Laking (corr. WSF).

38. *Quercus prinoides* Willd.—DWARF CHESTNUT OAK.

This oak has a shrubby habit and produces acorns when about three feet high. In Ontario it is known in only three localities which many other southern plants find eminently congenial: the sandy tracts on Point Pelee, near St. Williams, and along the last arm of the Aux Sables River. In the last-mentioned locality it is quite abundant and on some of the higher wooded dunes may attain a height of ten feet or over while retaining its multi-stemmed habit of growth. Because of the unusual form of its leaves it is not commonly recognized as an oak.

The records for this species have been plotted on map 38, Fig. 33, and are listed below:

ESSEX: on the sands of Point Pelee, Aug. 7, 1932, *Fr. Marie-Victorin et al. 49258* (MT, TRT). LAMBTON: sandy soil south of Grand Bend, July 17, 1940, *J. H. Soper et al. 2153* (DAO, GH, McM), sand dunes, Port Franks, July 10, 1939, *W. S. Fox* (WO); north side of "The Cut" near Port Franks, June 20, 1948, *Soper & Dale s.n.* (TRT). NORFOLK: lot 19, conc. VI, Walsingham Tp., about 2 miles northwest of St. Williams Forestry Station, May 31, 1951, *Soper & Landon 5188* (TRT).

39. *Quercus Prinus* L.—ROCK CHESTNUT OAK.

In Ontario this species appears to be restricted to the Carolinian region. It is not a common tree but occurs scattered with other oaks chiefly in limestone and sand dune areas. It has undoubtedly been confused with *Q. Muehlenbergii* both in the herbarium and in the literature and possibly also with *Q. bicolor*. The range as determined by the present authors is shown on map 39, Fig. 33, and the records are listed below:

BRANT: New Durham, July 30, 1934, *R. F. Cain* (TRT). ESSEX: Amherstburg—Macoun (12), but no specimens seen (collections from Point Pelee by Burgess and so labelled are *Q. Muehlenbergii*). KENT: lot 6, conc. VIII, Zone Tp., June 25, 1950, *J. H. Soper* (s.r.). LAMBTON: sandy field, Port Franks, July 18, 1950, *J. H. Soper et al. 2216* (DAO, GH, McM); near top of large sand hill near Port Franks, Sept. 11, 1941, *J. H. Soper 2849* (TRT);

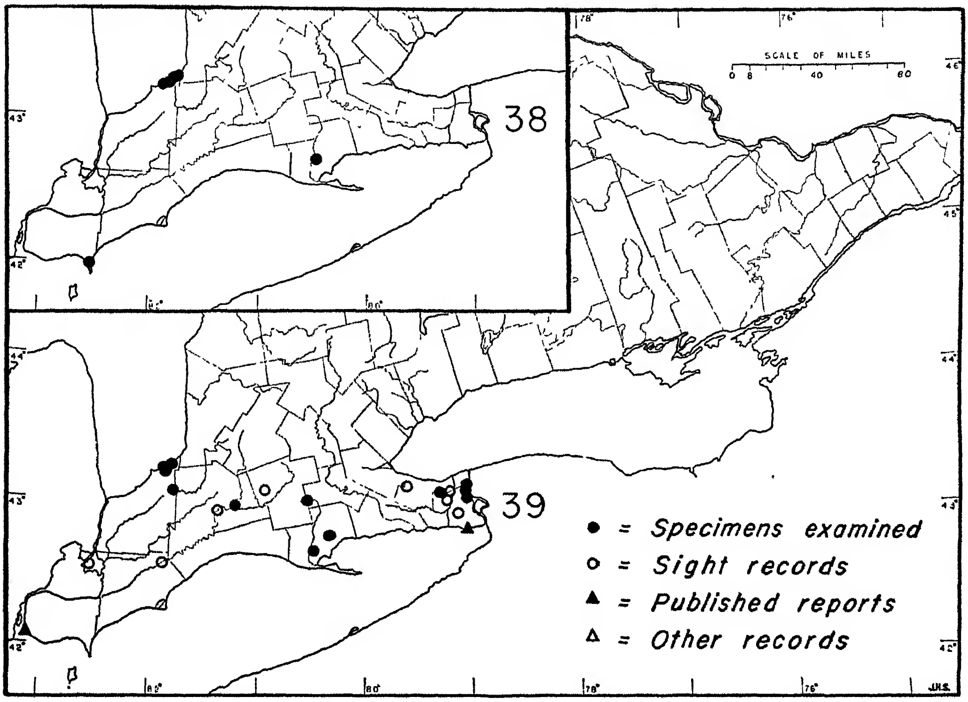

FIG. 33. Map 38: Distribution of Dwarf Chestnut Oak (*Quercus prinoides*).
Map 39: Distribution of Rock Chestnut Oak (*Quercus Prinus*).

rocky slope of ravine, Arkona Rock Glen, Aug. 5, 1950, *Soper & Shields 5132* (TRT); Squirrel Is., Lake St. Clair, July 24, 1948, *J. H. Soper* (s.r.). LINCOLN: one mile southeast of St. David's, Oct. 15, 1952, *Bert Miller 810* (McM); woods on slope below escarpment, Rockway, Aug. 13, 1952, *J. H. Soper* (TRT); lot 17, conc. X, Grantham Tp., June 18, 1950, *J. H. Soper* (s.r.); lot 19, conc. VII, S. Grimsby Tp., June 19, 1950, *J. H. Soper* (s.r.). MIDDLESEX: border of sandy woods near London, Aug. 25, 1886, *J. A. Balkwill* (McG); about one mile south of Lobo Station, June 24, 1950, *J. H. Soper* (s.r.). NORFOLK: lot 18, conc. VI, Charlotteville Tp., Aug. 31, 1948, *M. Landon* (ML); lot 19, conc. V, Walsingham Tp., 1937, *M. Landon* (ML). OXFORD: lots 6–7, conc. XIV, Nissouri E. Tp., May 31, 1950, *J. H. Soper* (s.r.). WELLAND: Niagara Glen, Aug. 10, 1949, *A. E. Straby* (OAC); lot 5, conc. IV, Crowland Tp. & near Thorold, June 18, 1950, *J. H. Soper* (s.r.); Point Abino (*Day*)—Burgess (50).

II. THE RED AND BLACK OAKS.—The chief features possessed in common by the members of this group are leaves with sharply lobed margins, the tips of the teeth having the veins protruding beyond the leaf margin as bristles, bark often dark, furrowed, but rarely flaky, acorns requiring two years to mature and with the inner surface of the shell of the nut hairy.

40. *Quercus palustris* Muenchh.—PIN OAK.

Territorially, this oak and the Swamp White Oak are in the same class in the United States and Canada jointly (see *Q. bicolor*, above), but the Pin Oak is only found for a short distance north of the international boundary at each end

of the zone between the Niagara River and the Rivers Detroit and St. Clair. *Q. palustris* is a tree of low damp ground and swampy rather open woods in Ontario. Its distribution is shown in Fig. 34, and the records are listed below:

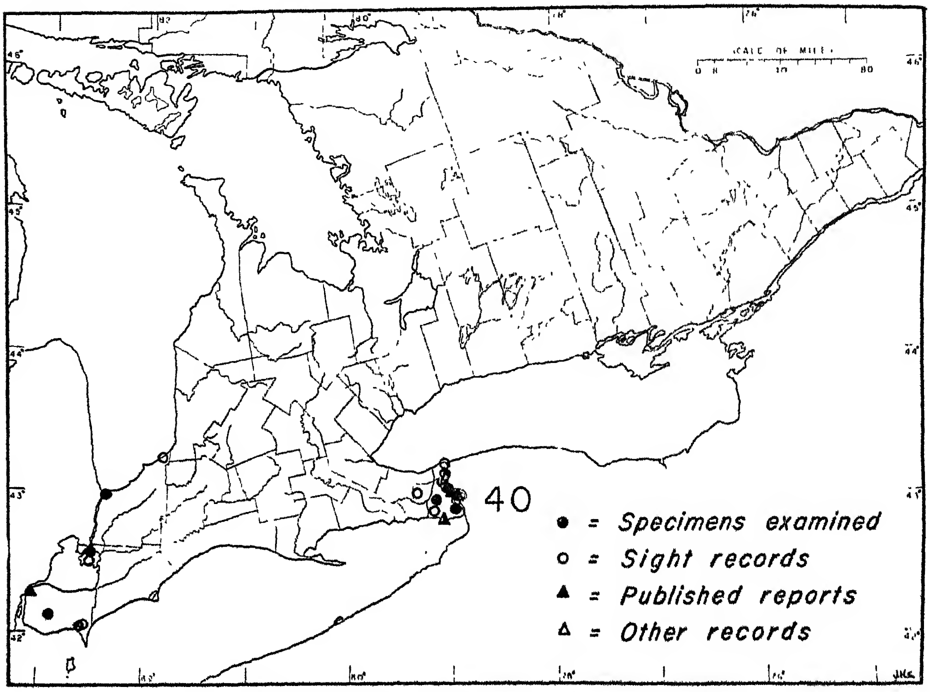

FIG. 34. Distribution of Pin Oak (*Quercus palustris*).

ESSEX: low open woods southwest of Essex, June 17, 1953, *J. K. Shields 1312* (TRT); Leamington, July 1, 1882, *T. J. W. Burgess* (McG, TRT); Windsor—Macoun (12). LAMBTON: Walpole Island, July 13, 1896, *C. K. Dodge* (CAN); low grounds, Pt. Edward, Sept. 14, 1884, *J. M. Macoun* (CAN); south end of Walpole Is., Aug. 4, 1950, *J. H. Soper* (s.r.); in a low damp valley between two long dunes, the Pinery between Grand Bend and Port Franks, 1928, *W. S. Fox* (s.r.). LINCOLN: Queenston Heights, Aug. 28, 1897, *Wm. Scott* (CAN, TRT); Three-Mile Creek near Niagara-on-the-Lake, July 14, 1954, *J. H. Soper* (s.r.). WELLAND: swampy woods about 2 miles east of Cooks Mills, June 18, 1950, *Soper & Shields s.n.* (TRT); heavy land, lot 10, conc. V, Bertie Tp., Sept. 20, 1950, *Bert Miller 163* (McM, TRT); Niagara Falls, 1950, *A. M. Dew* (NPC); lot 5, conc. IV, Crowland Tp. & lot 11, conc. III, Humberstone Tp., June 18, 1950, *J. H. Soper* (s.r.); in damp rich flat woodland near Fonthill, *W. S. Fox* (s.r.); Point Abino (*Day*)—Macoun (12); Navy Island, Niagara River—Hamilton (26).

41. *Quercus velutina* Lam.—BLACK OAK.

The continental distribution of the Black Oak is very similar to that of the Sour Gum and the Black Walnut. In Ontario, however, it reaches much farther to the northeast than these two, its range almost coinciding with that of *Quercus Muehlenbergii* (Fig. 32). The distribution is plotted in Fig. 35, and the records follow:

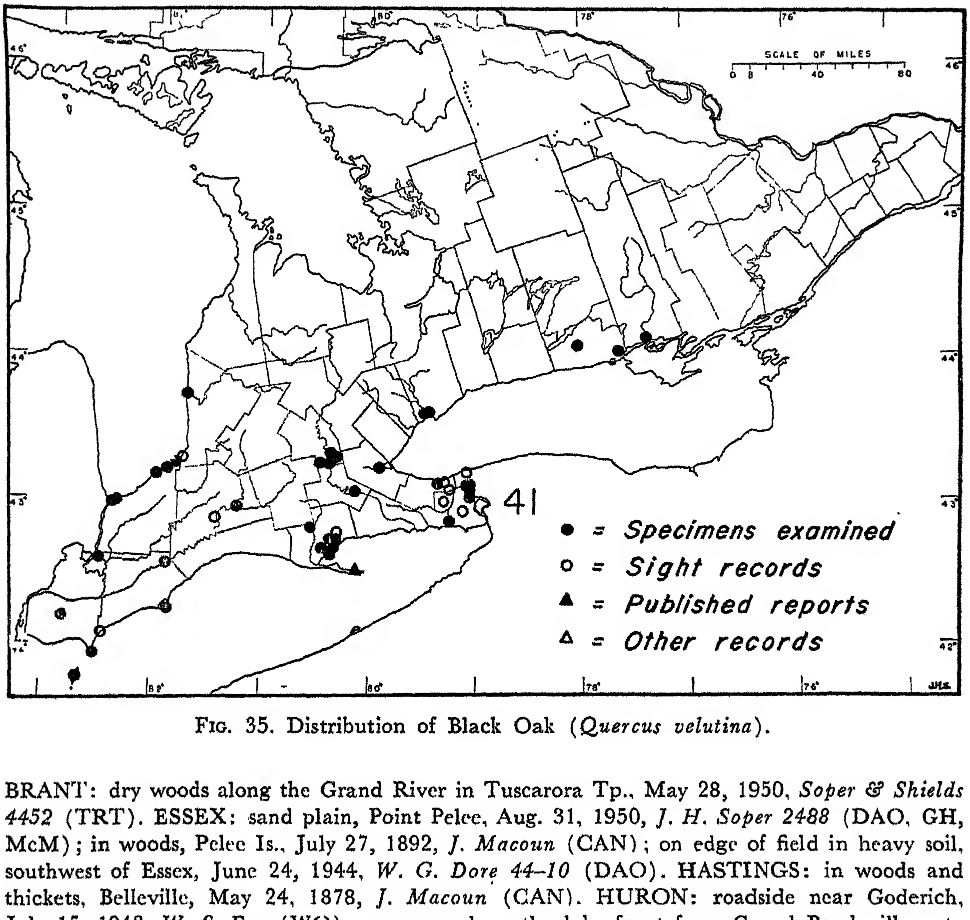

FIG. 35. Distribution of Black Oak (*Quercus velutina*).

BRANT: dry woods along the Grand River in Tuscarora Tp., May 28, 1950, *Soper & Shields 4452* (TRT). ESSEX: sand plain, Point Pelee, Aug. 31, 1950, *J. H. Soper 2488* (DAO, GH, McM); in woods, Pelee Is., July 27, 1892, *J. Macoun* (CAN); on edge of field in heavy soil, southwest of Essex, June 24, 1944, *W. G. Dore 44–10* (DAO). HASTINGS: in woods and thickets, Belleville, May 24, 1878, *J. Macoun* (CAN). HURON: roadside near Goderich, July 15, 1943, *W. S. Fox* (WO); common along the lake front from Grand Bend village to north end of Oakwood, *W. S. Fox* (s.r.). KENT: sandy plain, Rondeau Park, Aug. 16, 1940, *J. H. Soper 2396* (DAO, GH, McM); dry woods about 3 miles southwest of Bothwell, June 25, 1950, *Soper & Shields 4802* (TRT); woods southeast of Wheatley, Aug. 3, 1950, *J. H. Soper* (s.r.). LAMBTON: sandy soil about 2 miles south of Grand Bend, July 17, 1950, *J. H. Soper et al. 2164* (DAO, GH, McM); sandy field, Port Franks, July 18, 1940, *J. H. Soper et al. 2219* (DAO, GH, McM); Kettle Point, July 19, 1940, *L. O. Gaiser* (McM); Point Edward, Oct. 11, 1915, *C. K. Dodge* (A); in woods west of Blackwell, July 24, 1944, *H. Groh 2208* (DAO); near the ferry landing, Walpole Is., July 25, 1944, *W. G. Colgrove* (WO). LINCOLN: woods along east side of Twenty-Mile Creek between Jordan and Jordan Station, July 4, 1950, *Soper & Shields s.n.* (TRT); St. Davids, Sept. 3, 1898, *Wm. Scott* (TRT); woods about 2 miles south of St. Catharines, June 18, 1950, *J. H. Soper* (s.r.); lot 8, conc. III, Louth Tp., May 29, 1951, *J. H. Soper* (s.r.); Three-Mile Creek near Niagara-on-the-Lake, July 14, 1954, *J. H. Soper* (s.r.). MIDDLESEX: in woods, London, Oct. 4, 1881, *T. J. W. Burgess* (TRT); woods near Mt. Brydges, July 19, 1950, *J. K. Shields* (s.r.). NORFOLK: ravine along shore cliff, Turkey Pt., Sept. 17, 1938, *J. H. Soper 751* (McM); dry turfy woods northwest of Port Ryerse, July 14, 1940, *J. H. Soper 2089* (DAO, GH, McM); on the sand, Normandale, July 3, 1936, *Fr. Marie-Victorin et al. 46383* (MT, TRT); Delhi, Aug. 3, 1930, *H. H. Brown* (TRT); Vittoria, June 6, 1951, *M. Landon* (ML); lots 2–3, conc. III, Woodhouse Tp., Aug. 27, 1952, *J. H. Soper* (s.r.); Long Point—Synder (40). NORTHUMBER-

LAND: 2 miles north of Centretown, Aug. 13, 1948, *Soper & Dale s.n.* (TRT); dry sandy ridge 3 miles west of Trenton, July 16, 1947, *W. G. Dore 47–279* (DAO). WATERLOO: edge of marsh near Ayr, Sept. 6, 1941, *F. H. Montgomery 849* (DAO, McM, OAC); field at Veitch's Lake, Galt, Sept. 27, 1902, *W. Herriot* (OAC); sandy loam near Wrigley's Corners, Aug. 11, 1941, *F. H. Montgomery 848* (DAO, McM, OAC). WELLAND: Humberstone, June 28, 1931, *H. H. Brown* (TRT); sandy soil, lot 25, Stamford Tp., May 25, 1950, *Bert Miller 4* (McM, TRT); woods, Niagara Falls, May 21, 1938, *M. D. Kirk* (MDK); near Snyder, May 21, 1950, *J. H. Soper* (s.r.); near Fonthill, May 22, 1950, *J. H. Soper* (s.r.). WENTWORTH: wooded slope, Binkley's woods [W. Hamilton], May 10, 1943, *F. T. Knapp* (McM). YORK: sandy soil, Little Grenadier Pond, Toronto, June 4, 1941, *D. W. Kirk* (MDK); in woods, Humber Plains, Toronto, May 16, 1896, *Wm. Scott* (TRT).

EXCLUDED SPECIES

42. *Quercus coccinea* Muenchh.—SCARLET OAK.

Concerning the occurrence of this species in Canada John Macoun stated (12) in 1886: "The limits of this tree are very uncertain, owing to the confusion that exists in the minds of collectors regarding it and *Q. rubra.* In University Park, Toronto, are a few fine trees, but they become more numerous to the west and in the forest along the Niagara River and Lake Erie, it is an abundant tree. More investigation is necessary before we can fix the exact limits of this species (*Macoun*). Vicinity of Toronto (*A. Fowler*)." After watching for Scarlet Oak in the field for many years and examining numerous herbarium specimens so labelled, the authors still have not found any clear-cut evidence that this species exists in Ontario today. That it once occurred here is quite possible but today confusion with *Q. rubra, Q. velutina,* and *Q. palustris* has resulted in a host of misidentifications and erroneous reports. In Indiana, Deam (52) stated that he believed that Scarlet Oak "has its mass distribution in the unglaciated area, and outside of that it is a rare and local tree". Harlow (64) has excluded it from most of the state of New York. Although the general range as given in many floras and manuals often includes Ontario, we believe that this species stops just short of our province.

The most likely territory for Scarlet Oak in Ontario would undoubtedly be the Carolinian region, particularly the Niagara peninsula and the counties at the West end of Lake Erie. By no means have these areas been completely botanized nor thoroughly searched and those who may be in the field in these areas should be on the watch for Scarlet Oak. In the meantime, it seems best to exclude this species from the list until convincing evidence appears.

DISCUSSIONS AND CONCLUSIONS

THE CAROLINIAN ZONE

Having now presented our interpretation of the ranges of forty-one trees and shrubs in southern Ontario, the next step is to use this information to determine (1) whether the distribution patterns of these species fall into any recognizable groups and (2) whether it is possible to draw a northern boundary for the Carolinian Zone in Ontario. Before summarizing the data, however, it may be of

interest to present a short historical account of the various boundaries and names proposed for the Carolinian Zone in Ontario.

Several different schemes have been put forward for dividing North America into so-called "natural" vegetational or biotic areas. Each proposal has set up its own limits for the different zones or regions which it has recognized. A study of these systems reveals some conflicting data and opinions. At the same time it seems quite evident from the present study that southern Ontario does have some sort of a natural boundary (and probably two) separating vegetational associations of different composition or affinity.

In a now classic paper on Life Zones and Crop Zones of the United States published in 1898, C. H. Merriam (68) proposed the terms BOREAL, AUSTRAL and TROPICAL for three main regions stretching from the polar seas to Florida. Six subordinate zones and other sub-divisions were presented in his classification. Merriam's boundaries were related to isotherms, the chief criterion being the total quantity of heat units available to the plants (or animals) in different areas. This classification has been useful for certain purposes and has stimulated further research along the same lines. It is obvious, however, that no one could hope to present a completely accurate account of the distribution of the flora and fauna on a continent as large as North America without a tremendous amount of data at hand. The early attempts were certainly done with a meagre supply of facts.

The Austral Region of Merriam's system was divided into a Transition Zone, an Upper Austral Zone and a Lower Austral Zone. In the east the boundary between the Alleghanian Area (of the Transition Zone) and the Carolinian Area (of the Upper Austral Zone) was drawn by Merriam across Southern Ontario from the north end of Lake St. Clair to the west end of Lake Ontario. The Carolinian Area was defined by Merriam as that area ". . . in which the sassafras, tulip tree, hackberry, sycamore, sweet gum, rose magnolia, redbud, persimmon, and short-leaf pine first make their appearance . . . [counting from the north] . . . together with the oppossum, gray fox, fox squirrel, cardinal, Carolina wren, tufted tit, gnatcatcher, summer tanager, and yellow-breasted chat. Chestnuts, hickorynuts, hazel-nuts, and walnuts grow wild in abundance. The area is of very great agricultural importance".

It should be pointed out here that there has not been any uniformity in the use of the term "Carolinian". This term was proposed as early as 1859 by J. G. Cooper (51) in discussing forest tree regions of North America. The area to which he assigned the name was a strip along the coastal plain of the Atlantic states from southern Long Island to Georgia and including therefore the eastern part of the Carolinas. In 1892, J. A. Allen (48) used the same term for a faunal region in discussing the distribution of North American mammals. The region occupied by Allen's Carolinian fauna was quite extensive, stretching from the Carolinas north to New Jersey, westward south of the Great Lakes to the eastern edge of South Dakota and south to the northeastern corner of Oklahoma.

According to L. R. Dice (53): "The area now usually called 'Carolinian' by biogeographers follows closely the map of J. A. Allen (1892: pl. 8)." Dice, al-

though essentially following Allen in the use of the term Carolinian, has drawn the western boundary farther east than Allen did, "making it fall near the eastern border of the prairies". The whole area of the Carolinian biotic province has been described by Dice as forming "The middle section of the great deciduous forest lying along the Atlantic Coast of North America" (53, p. 16 and map 1).

Here then are four different interpretations of a Carolinian Zone or area in North America and two of them exclude any part of Canada. A final point to be kept in mind is that, as far as Ontario is concerned, not all the species confined to or characteristic of the so-called Carolinian area of the extreme southern part of the province have the same distribution in the rest of the continent, i.e. are typical Carolinian species in the sense of Merriam or of Dice. Some are found only in the eastern, central, or western parts of the great deciduous forest region, while others extend beyond the limits given for a Carolinian region by either of those two authors. An enumeration of the true Carolinian species of North American plants cannot be made until some uniformity is reached in the designation of the limits of such a region and accurate maps of the distribution of the so-called or suspected Carolinian types are available.

Turning now to the situation in Southern Ontario, we find that several accounts of the floral regions have been written. In 1915 Macoun and Malte (66) described a Carolinian Zone and stated that it was "confined to a small tract of land in southern Ontario, bounded to the south by Lake Erie and to the north by a line running approximately from the northern shore of Lake Ontario to Windsor. Its flora is most typically developed in the Niagara peninsula and on the very shore of Lake Erie. In general physiognomy it is rather similar to the hardwood forest flora . . . but differs greatly as far as characteristic species—and even genera—are concerned. It is decidedly southern as to species, and exhibits a large number of forms which occur nowhere else in Canada."

"The most characteristic trees are the Hickories (6 species), the Oaks (10 species), the Black Walnut (*Juglans nigra*), the Chestnut (*Castanea dentata*), and the Sycamore (*Platanus occidentalis*). Less abundant and more local in their distribution are: Cucumber tree (*Magnolia acuminata*), Tuliptree (*Liriodendron Tulipifera*), Flowering Dogwood (*Cornus florida*), which have all beautiful and very conspicuous flowers, Papaw (*Asimina triloba*), Red Mulberry (*Morus rubra*), American Crab Apple (*Pyrus coronaria*), Sour Gum (*Nyssa sylvatica*), Sassafras (*Sassafras variifolium*) and others."

"The herbaceous vegetation is very rich, at least a hundred species occurring nowhere else in Canada being found in the zone. A few of the most conspicuous may be mentioned, viz.: yellow Nelumbo or "Lotus Flower" (*Nelumbo lutea*), May Apple (*Podophyllum peltatum*), Wild Lupine (*Lupinus perennis*), Tick Trefoil (*Desmodium*), Flowering Spurge (*Euphorbia corollata*), Swamp Rose Mallow (*Hibiscus Moscheutos*), Wild Pansy (*Viola Rafinesquii*), Prickly Pear (*Opuntia Rafinesquii*), Poke Milkweed (*Asclepias phytolaccoides*), Wild Potato Vine (*Ipomoea pandurata*), Downy Phlox (*Phlox pilosa*), Waterleaf (*Hydrophyllum appendiculatum*), Bee Balm (*Monarda didyma*), Foxglove (*Gerardia pedicularia, G. virginica*), Tall Bellflower (*Campanula americana*), Great Lobelia

(*Lobelia siphilitica*), Ironweed (*Vernonia altissima, V. illinoensis*), Dense Button Snakeroot (*Liatris spicata*), Prairie Dock (*Silphium terebinthinaceum*), Cup Plant (*Silphium perfoliatum*), Sunflower (*Helianthus decapetalus, H. divaricatus*), Tall Coreopsis (*Coreopsis tripteris*), Indian Plantain (*Cacalia tuberosa*). Golden Seal (*Hydrastis canadensis*) and Ginseng (*Panax quinquefolium*) were at one time abundant but are now practically extinct." Most of the species in this last group are restricted to the area mentioned (i.e. south of a line from Toronto to Windsor), but at least one is found elsewhere in Ontario, namely the May Apple (*Podophyllum peltatum*). The distributions of the trees mentioned by Macoun and Malte have been studied for the present paper and maps presented for all but three species of oaks referred to in the discussions concerning that group of species.

In 1927 John Adams (45) defined as the Southern Region of Canada "The part of the province of Ontario lying south and west of a line drawn from Kingston to Collingwood on Georgian Bay". Although Adams did not use the word "Carolinian" in that paper, he listed many of the same species mentioned by Macoun and Malte as restricted to their smaller area. In particular Adams listed eleven families (with fifteen genera) and thirty-two other genera, all of which were said to be restricted to his "Southern Region". Writing for the Canada Year Book eleven years later, Adams (46, 47) used the term Interlacustrine or Carolinian Region. The northern limit of this region was not described but was shown on a map (loc. cit., p. 39) as approximately Sarnia to Toronto. Although there was a very considerable reduction in area from Adams' Southern Region (1927) to his Interlacustrine or Carolinian Region (1938), the same lists of eleven families and thirty-two other genera were cited as peculiar to the smaller area.[7] An additional statement was made, namely, that "There are 262 species in this area which are not indigenous to any other part of Canada" but unfortunately only a relatively few of these were specified by Adams.

One other account should be mentioned since it presents a boundary most closely resembling that which emerges from the present study. In his "Forest Classification for Canada", W. E. D. Halliday (63) has outlined a Deciduous Forest Region which he described as "The rather low-lying portion of the Ontario peninsula, enclosed by lakes Ontario, Erie, and Huron, [which] reaches the most southerly latitudes in Canada. This area enjoys very favourable climatic and soil conditions, which allow for the sole distribution in Canada of many Deciduous Forest species."

"The associations are predominantly composed of broad-leaved trees. A large number of these species, many of small size, find their northern limit here. Amongst these are chestnut, tuliptree, mockernut and pignut hickories, chinquapin, chestnut, scarlet, black, and pin oaks, black gum, blue ash, magnolia, papaw, Kentucky coffee tree, redbud, red mulberry, and sassafras. In addition, within this Section is the main distribution for Canada of black walnut, sycamore, swamp white oak, the shagbark hickory, together with the more widely dis-

[7]A special study of the families, genera, and species known or supposed to be restricted to these areas is currently being made by the junior author.

tributed butternut, bitternut hickory, rock elm, silver maple, and blue beech. All these species occur as scattered individuals or groups, either on specialized sites or within the characteristic association for the Section. This association, made up of widely distributed broad-leaved trees common in part to both the Great Lakes —St. Lawrence and the Deciduous Forest Regions, consists primarily of beech and sugar maple, together with basswood, red maple, and (northern) red, white and bur oak. The presence of the species listed above, and the predominance of beech within the characteristic association, indicate a definite relationship to an Ohio centre of distribution. Coniferous species are poorly represented; very scattered hemlock occurs within the characteristic association, on the lighter soils are small local areas of white pine, often with an understory of black and scarlet oak, and there is some presence of red juniper, generally on poor gravelly soils".

This Deciduous Forest Region in Southern Ontario, is, of course, just a small portion (at the northern edge) of the large deciduous forest formation which covers the greater part of the eastern United States. The Canadian portion confined to our Carolinian Zone has been designated by Halliday as the "Niagara Section", labelled D. 1 on the map which accompanies his paper. The boundaries of the various regions and zones just referred to have been plotted on our map in Fig. 36.

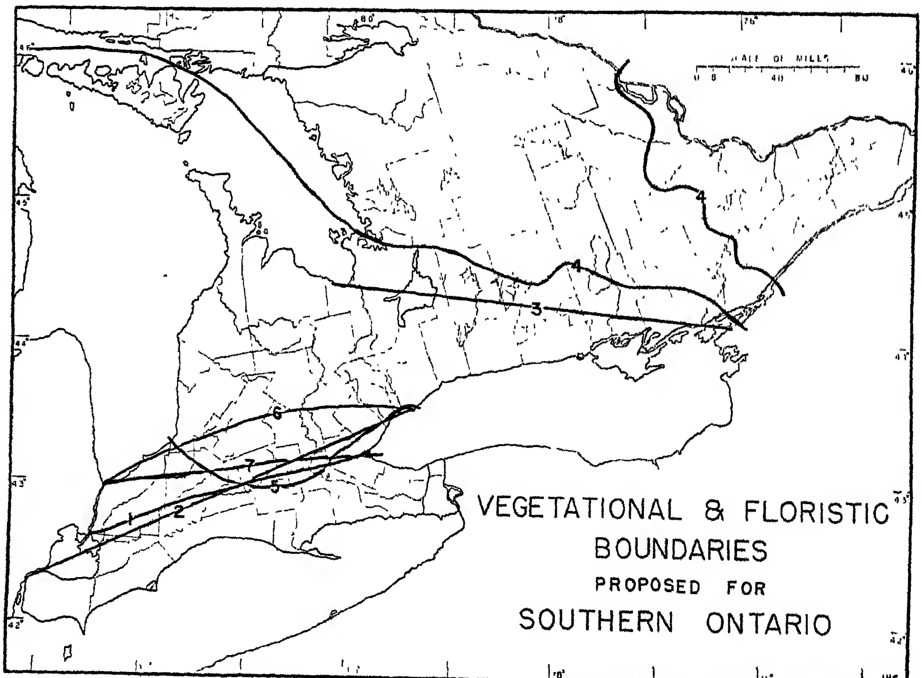

FIG. 36. Some of the vegetational and floristic boundaries which have been proposed for Southern Ontario: 1—Merriam (1898), 2—Macoun & Malte (1916), 3—Adams (1927), 4 & 5—Halliday (1937), 6—Adams (1938), 7—Dice (1943). (For discussion see text.)

SUMMARY OF THE DATA

After examining the distribution maps which have been presented it is possible to divide the species included in this paper into three main groups in regard to their range in Ontario as follows:

Group I. *Restricted to the Carolinian Zone.*

1. *Magnolia acuminata*
2. *Liriodendron Tulipifera*
3. *Asimina triloba*
4. *Sassafras albidum*
8. *Ptelea trifoliata*
10. *Cornus florida*
14. *Juglans nigra*
15. *Castanea dentata*
16. *Celtis tenuifolia*
17. *Morus rubra*
19. *Pyrus coronaria*
21. *Cercis canadensis*
22. *Gleditsia triacanthos* (indigens only)
23. *Gymnocladus dioica*
24. *Euonymus atropurpurea*
25. *Nyssa sylvatica*
26. *Fraxinus quadrangulata*
30. *Carya laciniosa*
31. *Carya tomentosa*
32. *Carya glabra*
33. *Carya ovalis*
34. *Betula lenta*
36. *Quercus bicolor*
38. *Quercus prinoides*
39. *Quercus Prinus*
40. *Quercus palustris*

In order to compare the ranges of these species more easily we have employed a technique found useful by H. M. Raup (70) and others which allows plotting a large number of species on one map. This consists of drawing lines connecting the marginal stations in such a way as to outline the limits to which each species is now known to extend. In this way the northern limits in Ontario for the twenty-six species in this first group have been shown on the map in Fig. 37. By no means do all twenty-six species have a common northern limit, but it is possible, if desired, to draw a mean or "smoothed curve" (as indicated by the heavy line AB on the map) which may then be taken to represent a boundary for the Carolinian Zone in Ontario. This boundary starts at about Grand Bend on Lake Huron, dips southeastward nearly through London, curves south of Oxford County, then northeastward around Galt and then east to include a strip along the north shore of Lake Ontario through Halton and Peel counties and the western part of York county to a spot just east of Toronto.

That there are certain dangers inherent in arriving at a vegetational boundary by using the ranges of individual species we are fully aware. The situation has been clearly stated by Dice (53, p. 6) as follows: "The limits of geographical range of species and races of plants and animals are not fully satisfactory criteria for determining the boundaries of biotic provinces and districts. Sometimes the limits of range for a number of species of plants or animals may coincide along the margin of a biotic area, and in such cases it will be found that there is some barrier to distribution at that place or some more or less abrupt change there in environmental conditions. Often, however, the range of a species does not stop abruptly at the border of a biotic province, but continues for a distance into the adjacent province. The reason for this seems to be that some isolated areas of

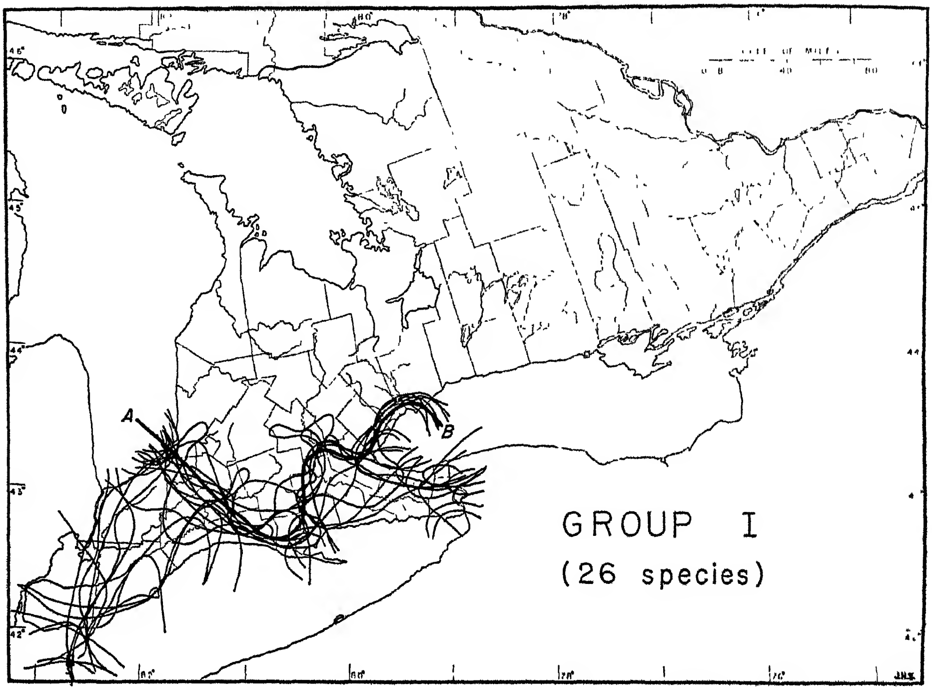

FIG. 37. Group I. The northern limits of twenty-six species restricted to the Carolinian Zone of Southern Ontario. (List in text.) The line AB represents a northern boundary for the Carolinian Zone.

suitable habitat usually occur in the adjacent provinces. Even a species characteristic of one province may thus occur far beyond the area of its greatest abundance." Dice has also stated that "a convenient means of fixing roughly the boundary between two adjacent biotic provinces is to draw the line at the place where the dominant associations of the two provinces cover approximately equal areas . . . the vegetation accordingly offers for the present the most satisfactory basis for distinguishing the major ecologic communities of the continent."

In the present case it should be pointed out that most of the area between Lakes Huron, Erie and Ontario is heavily settled, farmed or industrialized and the possibility of determining accurately the areas covered by the southern Deciduous Forest and by the northern Transition or Great Lakes-St. Lawrence Forest regions would be very small indeed. Such an ecological approach was not the intent of the present authors. However, it is believed that the indicator species of the Deciduous Forest such as Tulip Tree, Chestnut, Black Walnut, Sassafras, Flowering Dogwood, American Crab Apple, Papaw, etc., when plotted together show fairly accurately the limit of this Carolinian Zone in Ontario. There are a number of other species, of course, (as indicated by Dice) which are also characteristic of the Carolinian Zone but which are found beyond its limits to varying distances. Most of these are listed in the second group of species which follows.

There seems little doubt then, that there is one real and fairly definite boundary which can be drawn between Lake Huron and Lake Ontario after examining the ranges of these characteristically southern species of trees and shrubs. It does not correspond with the boundary of any known topographic feature nor with the limits of any special soil types. There is, however, a good correlation with climatic regions, particularly with the isopleths which have been presented by Putnam & Chapman (69), for the length of the frost-free period or the length of the growing season in southern Ontario. In other words, the position of the boundary is probably related to the climatic conditions of the environment rather than to any edaphic factors.

Since the ranges of all twenty-six species in Group I are not the same, the following division into smaller groups may be of interest:

I a. Typical "Carolinian" species.—*Sassafras albidum*, (Fig. 4), *Cornus florida* (Fig. 10), *Juglans nigra* (Fig. 15), *Castanea dentata* (Fig. 16), *Pyrus coronaria* (Fig. 19), and *Quercus bicolor* (Fig. 30). These six species have a wide distribution within the Carolinian Zone of southern Ontario essentially to its northern limit.

I b. Species chiefly in the southern part of the Carolinian Zone but not extending throughout to the northern limit.—*Liriodendron Tulipifera* (Fig. 2), *Asimina triloba* (Fig. 3), *Morus rubra* (Fig. 17), *Euonymus atropurpurea* (Fig. 23), *Nyssa sylvatica* (Fig. 24), and *Quercus Prinus* (Fig. 33).

1 c. Species found only at the western end of the Carolinian Zone.—*Cercis canadensis* (Fig. 21), *Gleditsia triacanthos* (Fig. 22. indigens only), *Gymnocladus dioica* (Fig. 21), and *Fraxinus quadrangulata* (Fig. 24).

I d. Species found only at the eastern end of the Carolinian Zone.—*Betula lenta* (Fig. 30).

I e. Species found at both the western and eastern ends but not continuous across the Carolinian Zone.—*Carya laciniosa* (Fig. 28), *C. tomentosa* (Fig. 28), *C. glabra* (Fig. 29), *C. ovalis* (Fig. 29), and *Quercus palustris* (Fig. 34).

I f. Four species most abundant on sandy areas along the lake shores and large rivers.—*Magnolia acuminata* (Fig. 2), *Ptelea trifoliata* (Fig. 8), *Celtis tenuifolia* (Fig. 17), and *Quercus prinoides* (Fig. 33).

The disposition of species into the groups and subgroups should be considered provisional only, for additional data may change the distribution patterns enough to put a species into a different category.

Group II. *Characteristic of the Carolinian Zone but with disjunct areas in the Georgian Bay, Lake Ontario, upper St. Lawrence or lower Ottawa River regions.*

5. *Lindera Benzoin*	28. *Carya cordiformis*
6. *Platanus occidentalis*	29. *Carya ovata*
7. *Xanthoxylum americanum*	35. *Quercus alba*
9. *Staphylea trifolia*	37. *Quercus Muehlenbergii*
12. *Populus deltoides*	41. *Quercus velutina*
18. *Hamamelis virginiana*	

In general, the eleven species listed above occur throughout the Carolinian Zone reaching slightly beyond the boundary drawn for that zone on the basis of Group I (see fig. 38). They also have additional stations in what are probably

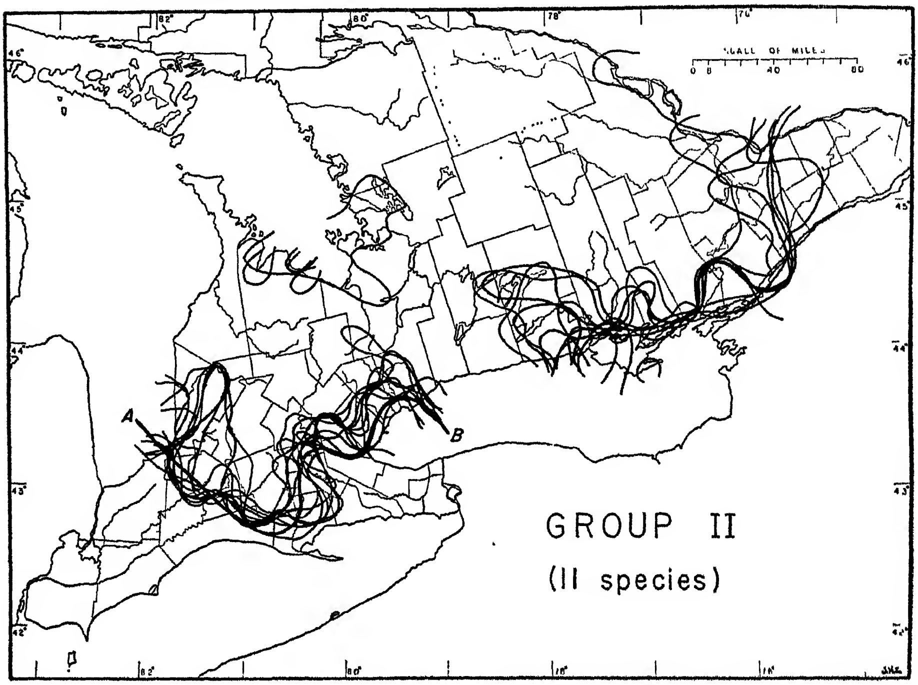

FIG. 38. Group II. The northern limits of eleven species characteristic of the Carolinian Zone but with disjunct areas in other parts of Southern Ontario. (List in text.) The line AB represents a northern boundary for the Carolinian Zone.

climatically favourable areas around Georgian Bay or along the north shore of Lake Ontario especially on or near the prominent peninsula of Prince Edward county or in the region along and between the St. Lawrence and Ottawa Rivers east of the Canadian Shield (cf. Fig. 11 in Part II). These species may also be divided into subgroups on the basis of the position of the disjunct part of their area.

II a. Species with their extra-Carolinian areas in the Georgian Bay region or along the north shore of Lake Ontario in or near but not east of Prince Edward County.—*Lindera Benzoin* (Fig. 5), *Platanus occidentalis* (Fig. 6), and *Quercus velutina* (Fig. 35). These species do not occur north of the contact line in the Canadian Shield region. *Quercus velutina* does not appear to have any stations in the Georgian Bay region as do the other two.

II b. Species with their extra-Carolinian areas along the north shore of Lake Ontario east of Lake Scugog and also in the eastern Ontario lowlands (between the Ottawa and St. Lawrence Rivers) but absent in the Georgian Bay region.—*Xanthoxylum americanum* (Fig. 7), *Populus deltoides* (Fig. 13), *Carya cordi-*

formis (Fig. 26), and *Quercus Muehlenbergii* (Fig. 32). *Quercus Muehlenbergii* is apparently absent in the Ottawa valley, in which it differs from the other three species.

II c. Species with extra-Carolinian areas in the Georgian Bay region, along the north shore of Lake Ontario and in the eastern Ontario lowlands.—*Staphylea trifolia* (Fig. 9), *Hamamelis virginiana* (Fig. 18), *Carya ovata* (Fig. 27), and *Quercus alba* (Fig. 31). Of these, *Quercus alba* is more widespread and more northern than the other three, its disjunct areas being so nearly contiguous as to form a transitional type to the next group. One peculiarity in its pattern is the apparent absence of this oak from the counties immediately east of Lake Huron and south of Georgian Bay.

Group III. *Species of the Carolinian Zone but occurring far to the north and east with a northern limit at about 46° N. latitude (approximately the south shore of Lake Nipissing).*

11. *Juniperus virginiana*
13. *Juglans cinerea*
20. *Prunus serotina*
27. *Cephalanthus occidentalis*

There is not very much similarity in the distribution of these four species in Ontario unless it be that they all appear to be absent in that part of the province north of Lakes Huron and Nipissing (see Fig. 39). Also records for these species

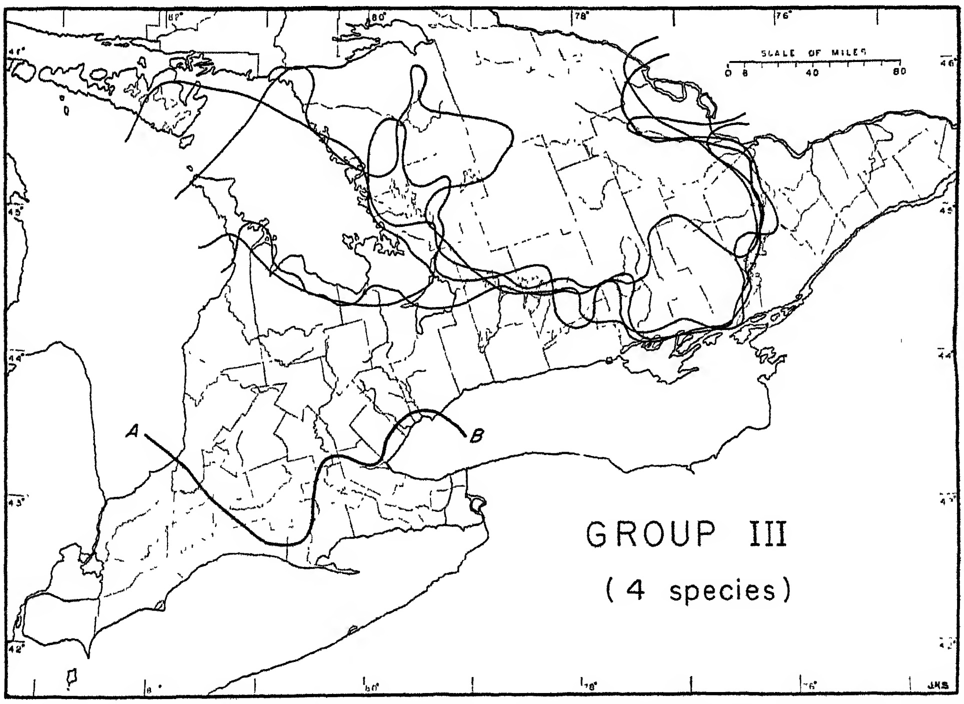

FIG. 39. Group III. The northern limits of four species common in the Carolinian Zone but ranging far to the north of it. (List in text.) The line AB represents a northern boundary for the Carolinian Zone.

in the upland area in and south of Algonquin Park are very scarce or lacking. *Juniperus virginiana* (Fig. 12) is found chiefly along the sandy and gravelly soils of the shores of the Great Lakes but also in rocky habitats along the contact lines between the Canadian Shield and the Ordovician to the south and east (cf. Fig. 11 in Part II). The apparent restriction of *Juglans cinerea* to habitats south and east of the Canadian Shield has already been noted under the discussion of that species in Part II of this series. The distribution pattern is similar to that of *Quercus alba* (cf. Figs. 14 & 31) with the exception that the latter shows stations along the east side of Georgian Bay and in the Muskoka Lakes district where *Juglans* is not found.

Prunus serotina (Fig. 20) and *Cephalanthus occidentalis* (Fig. 25) exhibit very similar patterns of distribution with the features noted above. One additional point which may be mentioned is that both these species are absent in the upper (or northern) part of the Bruce Peninsula although attaining a considerably more northern latitude on the east shore of Georgian Bay.

A consideration of the ranges of the species in groups II and III suggests that there is a second floristic or vegetational boundary in Southern Ontario related to edaphic rather than climatic factors of the environment. Such a boundary seems to be present along the contact line between the Canadian Shield and the Ordovician bedrock areas to the south and east of the Shield. This is essentially the basis on which Halliday (63) has delimited the southward extension in Ontario of the Algonquin-Laurentides Section (L. 4) of the Great Lakes-St. Lawrence Forest Region (see Fig. 36). A study of the distribution patterns of other non-Carolinian trees and shrubs and of herbaceous species of vascular plants may provide further evidence in support of this second vegetational boundary in southern Ontario.

ACKNOWLEDGMENTS

The authors are indebted to the curators of the herbaria listed from which material has been made available for study. Many others have kindly furnished specimens or data which have constituted valuable additions to our records. The junior author's field-work and researches have been generously supported by the University of Toronto, the Dominion Department of Agriculture, and the Research Council of Ontario. The gratitude of both authors is hereby recorded for the care and patience exhibited by Mrs. Margaret Heimburger in the sorting, filing, and initial plotting of the large number of records used in this study. Her assistance in this study has been invaluable.

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WHAT BIOLOGY?[1]

A. G. HUNTSMAN[2]

HISTORY OF OUR BIOLOGY

NO MATTER what biology we should have, we cannot escape from our past. The future can be built only upon the past, whether the old continues to stand or falls in ruin. Sound building for the future involves profiting from the past. The biology we have has come to us from the past. It is not a local product, except that it has been largely a development of Western Civilization. That development can perhaps be more easily appreciated by viewing it in a local setting. To work it out in any other setting than Toronto would be difficult for me. Since Toronto has developed contemporaneously with modern biology, it may provide as suitable a setting as any other place.

Just as ancient biology may be said to have started when Adam named the other living creatures in the Garden of Eden, that is, with the recognition by primitive man of other kinds of life, so modern biology is dated from 1758. In that year, the tenth edition of Carl von Linné's "Systema Naturae" firmly established our binomial nomenclature of the species of plants and animals. In that System, the characters by which each species may be recognized are given at some length, and the account of each concludes with a terse "Habitat" (Latin for "it lives"), that is, with an indication of where it actually lives. Has biology yet developed sufficiently from such a beginning for us to deal with it as a well-balanced whole? If it has, of what does actual living consist, and what is its relative importance in connection with the characters of the living organism?

Biology as the name of a distinct science originated only in 1802, when Treviranus introduced it in the title of a publication as being the Philosophy of Living Nature. By derivation it means the science of the course of life or of the manner or means of living. Accordingly it has at times been restricted in meaning to the life histories of organisms or to their physiology.

The French physiologist, Claude Bernard, defined life or living as the continuous adjustment of internal conditions to external conditions. He wrote in 1878 (Leçons sur les Phénomènes de la Vie): "Ce n'est point par une lutte contre les conditions cosmiques que l'organisme se developpe et se maintient; c'est, tout au contraire, par une adaptation, un accord avec celles-ci". The fact that living organisms are restricted to a very small part of the earth shows how essential for living it is to have peculiar outer physico-chemical conditions. The environment is as necessary for living as is the organism.

If living is the adjustment of the internal to the external conditions, the latter set the pace. But apart from that pace, living may be slow or fast depending upon the rapidity of the adjustments. The extent or degree of living will similarly depend upon the number and the variety of the adjustments. In rapidity of adjustment and in number and variety of adjustments, man may reach the

[1]Manuscript received March 22, 1954.

[2]Professor of Marine Biology, University of Toronto, Toronto.

utmost peak in living of which we have any knowledge. The measure of our living is the extent of our adjustments in adventure with the universe. Adventure is to be contrasted with teleology or purpose in life, an internal or subjective aspect which has dominated biological thought. Large as it may loom in our egotism, our ability to mould the universe to suit our purposes is very limited indeed.

If biology is to deal with actual living rather than merely with the structure and functioning of organisms, it must include knowledge of the physico-chemical environment. If living is adjustment of internal conditions to external conditions, it necessarily involves changes in the external conditions. I put forward the thesis that if biology is to be more than academic, it must include adequate knowledge of the dynamics of the actual physico-chemical environments of the organisms with which it deals.

DEVELOPMENT OF BIOLOGY AT TORONTO

Development of the modern science of biology has been roughly contemporaneous with the development of the University of Toronto. Teaching in the latter has naturally reflected the former.

In 1793, Colonel John Graves Simcoe of England, a leader of the Loyalists who had pressed northward from the States that had rebelled, crossed Lake Ontario from Niagara, to land at what is now Toronto. Having been appointed governor, he had the task of opening to settlers the recently founded Province of Upper Canada that has become Ontario. The name Toronto was used for the country generally, spreading on the whole north from this point on the lake. The only people established here were St. John Rousseau at the mouth of the Humber River and the Coon family, who were six miles up the Don River. In the vicinity of the town site, which the governor laid out on the shore of the harbour, there was nobody unless we believe the testimony of William Smith, a carpenter and builder of Niagara, who stated that he was with the governor and found three Indian wigwams on the east bank of the Don, in one of which was the Chief Kashago, and only one white settler, William Peak, with his family, who hunted and fished. The latter may have been the William Peeck, who applied in 1796 for land in the Township of Hope (Port Hope).

Toronto has developed in the short space of 160 years from the primitive wilderness that it was in 1793 to a sprawling city that with its suburbs contains well over a million people. The name, whether or not formally recognized, has again come to cover an indefinitely large area that radiates in all directions except over the lake from the harbour which was responsible for its somewhat forced selection as the capital of the then new Province. The University was at its inception given over a hundred acres out in the country and it at first owned both University Avenue and College Street, at the junction of which it was built. It is still there but engulfed by the city and shorn of most of its property, mainly by the Government, which throughout its history has been the arbiter of its destiny in the religious and political struggles that have chequered its history. As a site for the study of living things other than man and his diseases, it has

steadily deteriorated. This is perhaps best shown by the fact that in 1793 Mrs. Simcoe recorded in her diary for August 13 that her camp at the mouth of the harbour was being supplied with salmon by the Indian, Wable Casigo, doubtless the one living on the banks of the Don who is mentioned above as Kashago. Salmon disappeared from Ontario in the last century and recent experiments have shown that for long distances up from the lake the local streams now become so warm in summer as to kill even young salmon that withstand a higher temperature than can the adults.

Governor Simcoe urged on the British Government the immediate establishment at the Capital of a university to be supported by resources from the waste lands of the Crown and to be staffed, except in Medicine, by Anglican clergymen, "from which more than any other source or circumstance whatever . . . morality and religion will be fostered and take root throughout the whole Province". The Colonial Secretaries considered this to be premature and with his departure in 1796, the matter was left in abeyance for a quarter of a century. He had, however, set on foot enquiries toward getting someone from Scotland to take charge of such an institution. Dr. John Strachan, who responded, came to Upper Canada in 1799 to find the project dropped. When the opportune time came in 1826 for definite action, it was he who submitted to Governor Maitland an elaborate plan for founding a university with provision both for a Botanic Garden and a Gardener, and with Natural History, including Botany, as the third subject in his outline of study. He journeyed to England and obtained a Royal Charter for King's College in 1827. But, with control vested in the Anglican clergy, so much opposition was aroused that this College "with the style and privileges of a University" came into being only in 1843. Not one of the six Professors then appointed taught Natural History, nor was the subject mentioned among the different subjects of study at the opening of the College either by the President, Dr. Strachan, or by the Vice-President, Dr. McCaul. Instruction was to be for careers in Law, Medicine and Divinity. Medicine was of course applied biology and in the Medical Faculty there were Professors of Anatomy and Physiology and of Materia Medica, Pharmacy and Botany. What might be called pure biology was taught in Divinity. Natural Theology, with Paley as the textbook, was largely biological, the examination papers for 1847 having ten parts out of eighteen dealing with secretion in animal bodies, contents of chest and abdomen, seeds of plants, breathing and use of tails for oviposition in insects, larynx and trachea, blood system and nerves, venomous reptiles, protection of eyes and use of lachrymal fluid, roots and leaves of plants and their distinction from animals, and growth of plants.

When King's College was secularized and became the University of Toronto in 1850, teaching in Divinity was forbidden, but Paley's Natural Theology continued to be taught under Ethics, presumably because it was not a matter of religious dispute, being taught also by the Methodists at Victoria College.

As early as 1844, a chair in Agriculture was planned, in recognition of that basic need in the new country. The practical biology that it represented came to be taught in the University when the chair was filled in 1852. To illustrate the

principles of the practice with science, instructions were regularly given on the Experimental Grounds or farm attached to the University College.

Only in 1851 was a definite attempt made to establish a chair in Natural History, that is in biology. Its first occupant, the Rev. William Hincks, who had been a Presbyterian minister, was appointed in 1853. In accordance with the Linnean tradition, he was an ardent systematic naturalist. He built up a museum, which contained 6,000 species of plants, 1,000 of birds, 70 each of mammals and reptiles, 150 of fishes and some examples of the main groups of invertebrates.

The publication in 1859 of Darwin's Origin of Species gave biology a very great impetus and effectually divorced it from religion. Acceptance of evolution was thought to make biologists the opponents of religion. With such a background, Dr. R. Ramsay Wright came from Glasgow in 1874 to take the chair of Natural History. He taught evolution, but did not mention the word. Nevertheless, this teaching has been credited with preventing his becoming head of the University, although he became Vice-President. He was most effective in developing rapidly both teaching and research in biology.

Professor Ramsay Wright was a zoologist more than a botanist and equally concerned with its practical and its theoretical aspects. That he did not personally try to develop botany was doubtless owing to the fact that Agriculture, the important practical aspect of botany, was being handled in the University by Professor Buckland. Also, an Ontario School of Agriculture had been established at Guelph in 1874. Its affiliation with the University as a College in 1887 did not bring it sufficiently into relation with the Biological Department for the latter to develop with any feeling of responsibility for Agriculture. It was different with Medicine.

The importance seen in the application of science to industry brought about the establishment in 1878 of a School of Practical Science. The Professor of Chemistry was Chairman of the Governing Board and Ramsay Wright was the Professor of Biology and its Secretary. Although the first practical instruction in biology was given in the School, owing to the fact that accommodation for the classes was unavailable in the University or College building, where lectures had been delivered, it was inevitable that biology could have little scope for development in relation to a Faculty of Engineering towards which the School was headed from the first. However, the University Federation Act of 1887 made biology, that is, zoology and botany, a university rather than a college subject so that it had to serve all Faculties. At the same time, the Toronto School of Medicine became the Faculty of Medicine of the University. Medicine being one practical aspect of biology, it was natural that the old Moss Hall, in which the University had taught medicine before it went into isolation or retreat from professional teaching, should be replaced by a Biological Building, which was begun in 1888, and completed in 1892. The scope of its name was shown by its housing not only the Department of Biology but also the Departments of Physiology and Anatomy, so that it served as the headquarters for the Medical students at the University until a Medical Building was erected in 1904. With

this responsibility and association, it is small wonder that Ramsay Wright and his students should have put such great effort into the teaching of biology for students in Medicine that he was credited on retirement with being one of the two outstanding men on the continent who had done most to place medicine on a sound, scientific basis.

This achievement was possible only by his coupling scientific research with teaching and in this he was outstanding. He made early contributions to parasitology, which is allied to medicine. His early students were stimulated to engage in research. One, Dr. A. B. Macallum, became the Professor of Physiology and another, Dr. J. P. McMurrich, the Professor of Anatomy, and both began scientific research under his direction before the University had made any provision for it. The former played the most prominent role in the initiation in 1897 of research work in the University for the degree of Doctor of Philosophy.

Scientific research took Ramsay Wright and his students into a biological field that was far from Medicine. In contrast with the air and the solid earth, the waters support life throughout, by virtue of specific gravity, material content and fluidity. The opportunities they afford for study of life has been responsible for the establishment of biological stations on their shores beginning in Europe and spreading elsewhere. An Ontario or a Canadian Biological Station was a great desideratum. At the meeting of the British Association for the Advancement of Science in Toronto in 1896, Ramsay Wright advocated the establishment of a freshwater biological station, and then took a leading part in the movement emanating from that meeting that resulted in the establishment in 1898 of the Marine Biological Station of Canada. Thus began the strong support of fisheries research that now characterizes Canadian Universities. The Biological Board of Canada, consisting wholly of scientists from the universities was established for this purpose by Act of Parliament in 1912, and became the Fisheries Research Board of Canada in 1937.

The history of the development of knowledge in biology can only be glanced at, and in it Toronto has played, as is to be expected, but a small role. This development of knowledge has been largely "pure", that is, divorced from practical considerations. Its amount is prodigious. Taxonomy, which occupied the limelight following the work of von Linné, gradually decreased in relative importance and even came to be regarded as somewhat inferior, perhaps owing to its becoming to a great extent the mere identification and listing of species. It has largely become a Museum rather than a University responsibility. It continues, however, to be of prime importance in research and teaching. Embryology and morphology had a very great vogue in the latter part of the 19th century, but are relatively less important now. Physiology and genetics developed rapidly in the present century and there is no indication of any abatement in their prestige. Evolution with its concomitant, adaptation, has tended to dominate general biological thought, and to such an extent that biological textbooks are written with these forming the prevailing theme. The controversy between evolution and religion has for the most part died out. Ecology has been steadily

coming to the fore, but its descriptive and diffuse nature has prevented it from being recognized as science of the highest quality. If, as the derivation of the word implies, ecology deals effectively with the habitat, that is, with the actual living of the organism and with its environmental needs, it may well occupy an outstanding position. Pathology continues to be very important from its relation with medicine and agriculture, but it has no particular standing otherwise. It deserves recognition as a basic subject in any broad treatment of biology. Its practical importance depends upon whether or not we consider it preferable to ameliorate disease in the individual rather than either to get organisms that are fit for the particular environment or to make the environment fit for the organisms.

PRESENT ROLE OF BIOLOGY

The separation of biology into botany and zoology is a very natural one and the first occupant of the chair of Natural History in the University of Toronto took pains to indicate that this subject included zoology and botany, which are treated separately in his lectures. The separation was indeed thought by the first head of the separate Department of Botany to be so basic that he denied the existence of biology as a subject. Yet the separation was deplored by the head of the University. If plants can dispense with animals, animals cannot dispense with plants. Perhaps for this reason zoologists have been more inclined to be biologists than have botanists.

The roles that the Departments of Botany and Zoology are now playing in the University of Toronto are quite diverse. The average numbers of undergraduate students receiving instruction in these Departments for the five-year period from 1947 to 1952 in the various Faculties of the University and in associated Schools and Colleges have been as follows: *Botany*: Arts, 364; Medicine, 42; Engineering, 13; Household Science, 6; Forestry, 115; Pharmacy, 316. *Zoology*: Arts, 791; Medicine, 152; Household Science, 7; Forestry, 159; Dentistry, 87; Physical and Health Education, 89; Nursing, 19; Pharmacy, 35; Optometry, 51. The numbers of students graduating each year in the course in Biology were: 1948, 6; 1949, 10; 1950, 13; 1951, 10; 1952, 7. The numbers of these graduates (not proceeding to higher degrees) to enter the following fields of work have been: Government administration and research, 11; university and college teaching and research, 6; school teaching, 7.

The numbers of graduate students in the Departments of Botany and Zoology who have for the six-year period from 1947 to 1952 gone thence into each of the following fields of work have been: From *Botany*: Government administration and research, 29; university and college teaching and research, 11; school teaching, 2; industry, 1. From *Zoology*: Government administration and research, 30; university and college teaching and research, 17; museum administration and research, 3; school teaching, 4; hospital work, 1; industry, 2; public organization, 1; army 1.

At the present time, in the Faculty of Arts, biology is an obligatory subject in only six of the twenty-nine courses. It is an optional subject in four more, and

these are in Classics, Philosophy and Psychology, which reflects the breadth of their approach to knowledge. In the natural sciences, it is now omitted from the four courses for the basic sciences of Physics and Chemistry and is obligatory, not only in all the rather definitely biological courses, but also in the courses for the earth sciences of Geology and Geography.

A WELL BALANCED BIOLOGY

Common words are used so variously that my use of certain words should be made clear. Biology is the science of life or living things, that is, the knowledge needed for predictions concerning plants and animals. Life is the sum total of living things or of the activities of a living thing. Living is the activity. That activity is so complex and variable that, to make progress in understanding it, the biologist has felt it necessary to take one part at a time and more or less ignore the rest. He considers that he is studying the living or activity, but is really abstracting from it. The actual living of the plant or animal is its activity as a whole without any abstraction and without removing it from its natural environment.

It is quite unwise to be at all dogmatic as to the formal education that any individual should have for any particular field of work, when it is not a matter of his becoming expert in a particular technique that is to be used. Variety in the inherent capabilities of individuals is so great as largely to defy analysis and classification. The variety in the experiences of the individuals apart from their formal education is very great and is under little control. The variety in the situations for action that will confront the individual may be extremely great and they are little susceptible to prediction. For these reasons, those responsible for education in biology should merely try to ensure that the best knowledge of the subject for the time being is made available for whatever uses may develop for it. It is decidedly important to question the basic ideas in biology and to make sure that the sound ones are generally appreciated by whatever avenues they may be disseminated. Next in importance comes formal instruction in these basic ideas, and it is conceivable that, if they were more clearly formulated and illustrated, they would be found to be much more generally serviceable in university education than they are at present, particularly if they were not unduly loaded with less important detail. Such instruction would of course be particularly valuable to those who must deal practically with the living of organisms including man. Broadly that includes every person, but it is questionable when, in comparison with other educational demands, formal instruction in biological principles will be considered advisable or necessary. The basic need is undoubtedly for research, that is for the education of those who are to develop all the knowledge that may be required in connection with practical action on the living of organisms. The present educational situation for biology reflects that fact, in that the great majority of those who specialized in biology are engaged in research. Does this mean that a well balanced biology is still a matter, not of the present, but only of the future? Have we the scientific basis for practice in connection with actual living?

How is our ability to present a well balanced biology to be judged? Actual

living is dependent upon the external conditions, the environment. We need to know what is necessary for the habitat. This is a geographic, that is, a local, matter. We can properly start with our own places on the earth. What do we know of conditions for actual living of plants and animals in and near Toronto, as well as throughout Ontario and throughout Canada? To cooperate with those responsible for the subject of Geography in this University, we give courses in plant and animal geography. I have indicated how the development of Toronto and the settling of Ontario have altered conditions in the local waters, which are not man's habitat, so that salmon, once abundant here throughout the summer, disappeared. Although I have said that conditions here have steadily deteriorated for the study of life, except of man and his diseases, this expresses merely the popular view of city dwellers who idolize the wild. Do we know what kinds of life have gone from Toronto and also what kinds of life have come to Toronto in the past one hundred and sixty years? The true picture includes both of these. If we can present this picture, can we state with what changes in the environment these changes in actual living at Toronto are associated?

The passenger pigeon which formerly at times darkened the skies of Ontario has disappeared from the face of the earth. What changes in conditions caused this? Mrs. Simcoe in her diary for 1793 mentions the occurrence of great numbers of rattlesnakes at Burlington, which would clearly be the mississauga. None are now to be found nearer there than the Wainfleet marshes of Lake Erie or than the shores of Georgian Bay. What has been responsible?

Have we yet the scientific knowledge to predict for the particular environment what the actual living will be? If we should want different actual living from what now exists, can we state what changes would need to be made in the environment? In the broader field throughout Ontario and throughout Canada, what can we state of the environmental conditions that exist and of the kinds and quantities of actual living there can be with these conditions? Can we even begin to say for our country how many men and what kinds of men its conditions permit? As it happens, I have been studying for the past twenty years the actual living of the salmon, and have come to appreciate, to some extent, what is involved in presenting a well balanced biology for aquatic life. The biologists have the task of obtaining directly or through those concerned with the actual living of plants and animals, that is, those concerned with medicine, agriculture, forestry and wild-life, as well as those concerned with the fisheries to whom I have had to turn, the knowledge that is necessary for presenting the most important basic scientific principles for life or living.

Sir Edwin Ray Lankester, who was a power in zoology following Darwin in the latter part of the last century, when morphology was in its heyday, considered that a well balanced zoology must have five branches: "Morphography, the work of the collector and systematist. Bionomics, the lore of the farmer, gardener, sportsman, fancier and field-naturalist, including thremmatology, or the science of breeding, and the allied teleology, or science of organic adaptations. Zoo-Dynamics, Zoo-Physics, Zoo-Chemistry, the pursuit of the learned physician,

anatomy and physiology. Plasmology, the study of the ultimate corpuscles of living matter, their structure, development and properties, by the aid of the microscope. Philosophical Zoology, general conceptions with regard to the relations of living things (especially animals) to the universe, to man, and to the Creator, their origin and significances." However odd this outline of the proper scope of zoology may seem to us now, it should be noted that he starts with the work of von Linné and that he puts in second place knowledge of those concerned with the actual living of the animals. It is this latter which has been neglected because such knowledge is to be obtained far from the class room and the laboratory and because it has been considered an inferior kind of knowledge. I have used for it the term biapocrisis, the response of the organism as a whole to what it faces where it lives. Whatever words are used, the important point is that such knowledge of the actual living of the organisms must occupy a prominent position in any well balanced biology.

In biology as elsewhere, there is the conflict between the academic ideal of knowledge valued for its own sake, free from the contamination of the market place, and the practical ideal of knowledge to serve humanity in its need for effective action. In this conflict, the scientist enters the very controversial field of values, which belongs to the subjects of ethics and economics. Valuation seems inevitable in any attempt to have a well balanced presentation of biology. I do not hesitate to urge the practical ideal of knowledge to serve humanity in its need or desire for effective action, and, as a biologist but not as a citizen, I refrain from judging the need or desire. Any knowledge whatever may be considered as valuable for its own sake. For me to uphold the value of the knowledge which I have come to want or prefer rather than what others want seems to be a selfish attitude to take.

With the above declared object, a well balanced biology will be one that best serves human needs for effective action in connection with the life or living of man himself and of other organisms, as in the fields of medicine, agriculture, fisheries, forestry and wild life management. While it must include knowledge of the organisms themselves, its main concern should be with the adjustments of the organisms to the changes in the environments in which they live. There must be clear appreciation of those changes as well as of the adjustments to them. To what extent are we yet able to deal scientifically with these things, that is, to predict how the particular environment will change as well as to predict how the organism will adjust to the change. The farmer needs this knowledge in caring for his plants and animals and he must depend upon the meteorologist for predictions of the weather that affects them.

In the actual living of an organism, the most important things seem to be survival, growth and breeding. To these there may be added movement, which determines where the organism will go and survive or not survive, grow or not grow and breed or not breed, depending upon the environment. If biology is to mean the actual living of the organism, the most important part of the biology of any plant or animal will be its biapocrisis, that is, how it responds to what it

faces where it lives in *survival, growth, breeding* and *movement*. In a well balanced biology, the knowledge presented will be mainly determined by its significance for these four basic features of actual living.

It should be understood, however, that a biology which places emphasis on the environment rather than on the organism represents one only of two contrasted aims for human action in regard to organisms. It is not that of recovering and maintaining the health of the organism in spite of unfavourable environment, which aim man usually has for himself as the result of wanting unfavourable environment for one reason or another. The environment becomes of prime importance when the aim is to avoid an unfavourable, or to produce a favourable environment for the organism. Knowledge of the suitability of the environment is also important when it becomes a question of selecting or producing a kind of organism for a particular environment.

In dealing with the environment, the four elements of the ancients—earth, air, fire and water—come into consideration. Geology represents the first and provides the solid basis. Meteorology, which was in the early days an Arts course in the University and should be taught again, represents the second and gives the most potent complex changes. Astronomy includes consideration of the sun, whose fire provides energy for life. Hydrology represents water, the most important medium for life, which still remains to be developed in the University. For any such presentation of biology as has been suggested, there will be need for all the various subdivisions that have been mentioned on pages 135–6. The amount of time to be devoted to each in a well balanced scheme will need to be worked out. It is all too true that the enthusiastic specialist in any particular field will want to make each student also a specialist, if he can. It would perhaps be well to plan the details of the courses apart from the specialists, who would merely be responsible for helping the students to learn what is considered from the broad standpoint to be necessary for them to know. It is the responsibility of the student to acquire the knowledge and experience that will make his living an effective whole. It is the professor's duty to help him in this and especially to judge the result.

While the unverifiable matter of past origins is useful as an historical background, and while the idea applies as universally as time, evolution should not be our main concern. I venture to suggest that our objective for teaching and research in biology be to elucidate the *actual living of the various kinds of organisms*. For such elucidation, biology must consist as in the past of accounts of the kinds, as dealt with in detail in taxonomy and genetics, and of their structure, functioning and development, as dealt with in detail in morphology, physiology and embryology. For each kind the facts of structure, functioning and development will need to be presented as permitting *survival, growth, breeding and movement under particular external conditions*, which determine where and when, given a start, the kind will be found, that is, its *habitat*. For adequate knowledge of external conditions in elucidating actual living, appropriate aspects of *meteorology, hydrology* and *geology* will have to be included in both teaching and research.

A WOODLAND SITE NEAR CHATHAM, ONTARIO[1]

KENNETH E. KIDD[2]

INTRODUCTION

THE EXISTENCE of an Indian site on the farm of Mr. W. R. Krieger, near Chatham, Ontario, was first drawn to the attention of the Royal Ontario Museum of Archaeology in a letter dated November 14, 1948, from Mr. Neil Coppieters. Along with the letter, Mr. Coppieters sent a photograph of a vessel (Fig. 8, *right*) which he was able to restore from sherds found on the site, and which revealed clearly its Woodland character in its semi-globular shape, rounded bottom and apparently fabric-roughened exterior, but which also in its incised and mildly castellated rim suggested later affiliations. Further, Mr. Coppieters' observation that "a more elaborate, almost completely restored vessel, bearing incised chevrons on the neck beneath an impressed rim . . ." (Fig. 9) had been found, lent additional interest, while the finding of projectile points, bone awls, numerous sherds, several clay pipes, a stone axe, and a couple of burials indicated a relatively prolific site.

Its Woodland features made it desirable to give it serious attention, and in June of 1949 arrangements were made with Mr. Krieger to excavate as soon as the crop was removed in the late summer. Accordingly, with the writer in charge, a party of six spent a fortnight trenching the small area available for study, the results of which work are presented below.

Previous to 1947 no one seems to have been aware of the site's existence, but about that time several amateurs made surface collections from it. Mr. Coppieters and Mr. Stanley Wortner both examined it carefully in 1948, and in addition to making their surface finds did a certain amount of digging, in the course of which they located 23 pits and two or three burials. Mr. John Gazarek was able to restore a vessel from sherds which he excavated upon the site at that time (Fig. 9), and which is the second one referred to in Mr. Coppieters' letter. Mr. Walter Winberg collected some 50 stone scrapers, drills and projectile points wholly from the surface, and of these he very kindly supplied the excellent line drawings shown in Fig. 6. These are of considerable importance to this study since they comprise the majority of this type of artifact found on the site. If any other collections were made here, they have not come to the writer's attention. The site itself is located in Lot 7, River Range, Harwich township, Kent county.

Kent county, like adjacent parts of southwestern Ontario, was glaciated and its soils were laid down as glacial drift. In post-glacial times, lakes covered most of the area, in which sediments were deposited and the irregularities of the surface smoothed out (Richards, Caldwell and Morwick—Soil survey of Essex county). The present appearance is that of an almost flat plain, with slight undulations, through which the Thames river threads its way. By and large, the course of this stream runs fairly straight in a southwesterly direction, but in detail

[1]Manuscript received August 6, 1954.

[2]Curator, Department of Ethnology, Royal Ontario Museum of Archaeology, Toronto.

it does a good deal of meandering. It has cut a wide flood channel in most places, including its course through the Krieger farm. Within this flood channel it has cut a deeper, permanent channel, which at the above point keeps the western side. As a result of this circumstance, the Indian site here under study lies at present about 300 feet east of the permanent bank, at the very edge of the flood channel upon the plain (Fig. 1).

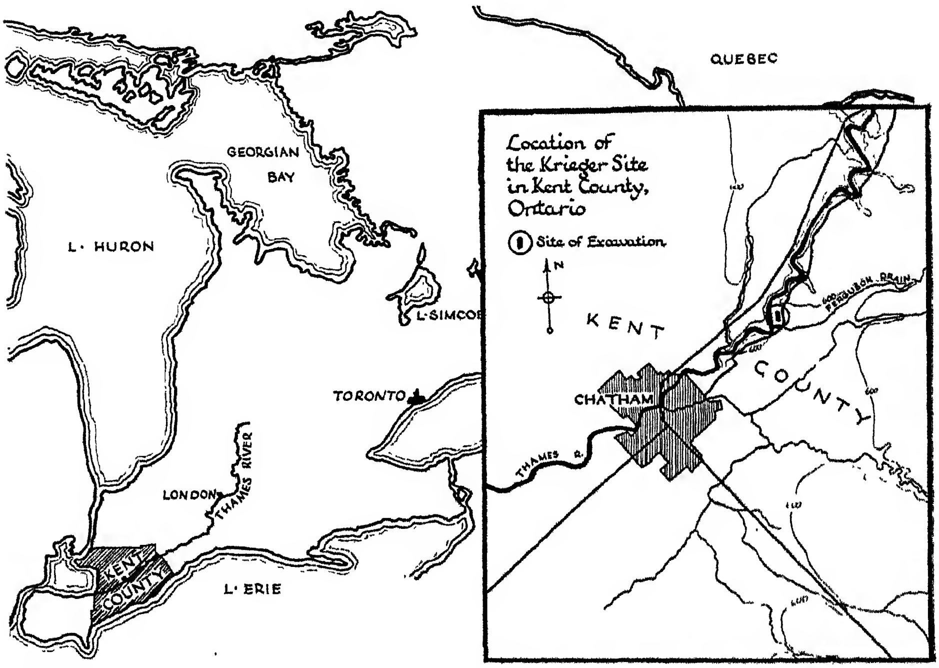

FIG. 1. Map to show the location of the Krieger site in Kent county, southwestern Ontario.

The normal elevation of the Thames' water is 578 feet above sea level (as of 1934), and the elevation of the site 600 feet. The land surface therefore is approximately 22 feet above the level of the water in the river. The slope from the one to the other is at first steep (8 feet in 65 feet), and then gradually drops to the river's bank. It is upon the brink of this drop that the site is located (Fig. 2, *above*).

There is no conspicuous difference between the soil in the flood channel floor and in the rest of the immediately surrounding plain. It is all described technically as "Thames clay loam," that is, "an imperfectly drained, reddish brown, friable clay with silty clay loam, neutral to alkaline" (Soil Map of County of Kent, 1936). In the areas where the excavation was conducted, however, the subsoil appeared as a hard-consolidated yellow sand with numerous lenses of red limonitic material which were extremely difficult to dig through. The surface soil was never deep; six to eight inches being the greatest depth found and in places it was considerably less. Erosion is taking its toll; to quote a letter from Mr.

FIG. 2. *Above*, view of the Krieger site from the northwest. The excavated area lies close to the barn, on the ridge. *Below*, an excavated PIT, showing the shape. The square is five feet.

Coppieters, dated November 29, 1948: "The depth of most pits is extremely uncertain, that is, the original depth, since the site is located on the edge of a bluff leading to the river flats, and is subject to excessive erosion. When I first visited the site, at least a score of gullies a foot or more in depth were seen. This and repeated cultivation are probably responsible for destroying many otherwise

restorable pots." Along the edge of the drop, the topsoil in places has been entirely washed away.

The site is bounded on the west by the river flats, and on the south by Ferguson Drain (Fig. 1). Immediately to the east are the farm buildings and the orchards, leaving only a ledge some 70 × 100 feet wide available for examination. From the evidence it would seem quite probable that the site extends much farther east but the presence of the farm buildings made investigation in that direction impossible. Across the road, on the adjacent farm, a number of projectile points have been picked up which closely resemble those found by Mr. Winberg on the Krieger site, indicating either that the latter extends that far and is thus much larger than is proven, or that people of a similar culture occupied the nearby spots at some time. As revealed by excavation, however, the Krieger site had a limited range on this bench, extending not more than 260 feet from north to south.

The northwest corner of the large barn, with a concrete foundation, was used as the bench mark, and its east-west wall taken as one of the co-ordinates of the grid. The other co-ordinate was at a right-angle to this and exactly 10 feet west of the north-south wall of the barn. Upon these co-ordinates the site was laid out in five-foot squares (Fig. 3). Excavation was conducted by removing three-inch levels of soil.

It should be mentioned that this area has been cultivated for a century or more; hence, can be by no means considered undisturbed ground. Furthermore, because of its proximity to the farm buildings, it has been used frequently as a place upon which to bury the remains of farm animals which have died. Finally, Mr. Krieger informed the writer that much of the surface of the field immediately west and south of the big barn had been scraped to provide material upon which to erect that building, so that that particular area has been much reduced. The disturbing factors thus are seen to be (1) cultivation; (2) the burial of farm animals; (3) the scraping of large areas; and last but not least, (4) erosion.

As the number of squares completely or partially excavated amounted to 54, about one-quarter of the available area which gave evidence of occupation was explored. Since, however, the evidence of occupation at the extremes of the excavation was very slight, most of it being located more centrally, it may be assumed that about one-third or even one-half of the richest culture-bearing portion was dug.

The area which was known to have been occupied was tested to determine the limits of occupation. Continuous trenches were run in fertile areas, but single squares only were excavated beyond these. While in the absence of continuous trenches running the full length of the site and crosswise of it, it cannot be maintained that the limits are known beyond dispute, nevertheless the results of the above procedure indicate clearly that the great majority of the pits and consequently of the cultural remains occurred in an area 90 feet from north to south, and half that from east to west, in the form roughly of a triangle situated along the edge of the plain, the southern end of which is approximately 170 feet north

of Ferguson Drain. At the north end of the triangle a disturbed burial was encountered, and 50 feet south of this, a complex burial, but these contained virtually no cultural material.

As already noticed, the topsoil was everywhere thin, never being more than six or eight inches deep and in places not more than two or three. It contained remarkably little cultural material. Out of some 34 artifacts (of bone, stone, shell but exclusive of pottery) found in the excavation, only seven were from the top six inches and five of these were found in that area which had been scraped for building purposes. We are probably correct in believing that the five had been recently exposed through erosion and that the remaining two had been repeatedly disturbed through ploughing.

Pits

It became obvious that the great majority of all cultural material was contained in aboriginal pits. These had been dug through the topsoil and into the hard sand below. No plan or system of arranging them had been followed. They were apparently merely dug wherever fancy prompted, for while some were isolated, many overlapped one another. Out of the total of 54 pits completely or partially excavated, only five are known definitely not to have overlapped. In 17 cases two pits overlapped, and in five cases, three overlapped. The remainder were only partially dug and hence are not completely known, but many of them probably would have shown overlapping. The zone of greatest concentration of pits was in the central area, covering a stretch about 70 feet from north to south and from the edge of the plain eastward about 45 feet. All but two pits lay in this zone. Some areas were so completely pitted in fact that the upper portions of the soil consisted entirely of pit contents.

Although there was a good deal of variation in shape and size, two principal types of pit were distinguishable; these may be called "bowl-shaped" and "beaker-shaped." The former were nearly twice as numerous as the latter and showed, generally speaking, sloping sides and flat or concave bottoms. (Fig. 2, *below*); whereas the beaker-shaped had vertical sides and either flat, concave or irregular bottoms. Diameters across the top ranged from 2½ to 11 feet, and depths from 16 inches to 42 inches, with the bowl-shaped variety, on the whole, somewhat larger than the beaker-shaped, and less subject to extreme variation. Top diameters of 4 to 5 feet and depths of between 20 and 30 inches were the most common dimensions.

Extremely shallow pits seem to have been reduced to that condition through erosion.

Analysis by Square

Since the excavation procedure involved the removal of material by square and level, pits were not opened as such. The advantages of the method were that (1) a good control was obtained over material by level; (2) excellent profiles were secured; and (3) floor graphs, photographs and positional data were

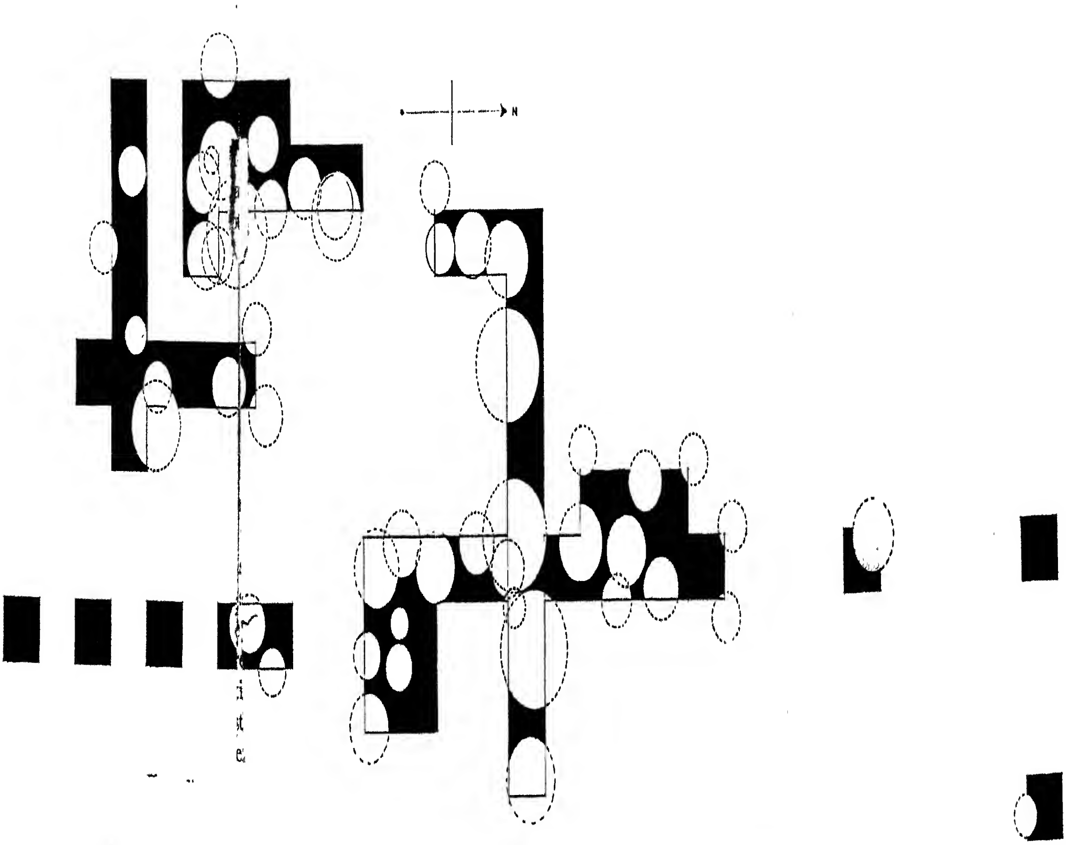

FIG. 3. Plan of excavation. The solid black areas represent five-foot squares; the circles, pits; and the shaded area, the locale of the group burial.

recorded in good detail. If there were disadvantages, they consisted in the non-isolation of material pit by pit. Almost every square revealed at least one pit, and some as many as three; under such circumstances, the keeping separate of material from the several pits became complicated. The advantages, however, probably outweighed the disadvantages, since the customary overlapping would have prevented their identification in any case until they had been excavated to a considerable depth. Beyond this depth, it was usually possible to isolate the remains according to pits, which was done.

Exploration of the culture-bearing triangle was done, not by continuous trenching but by making two groups of trenches. The more northerly of these was based upon a trench called the "4" trench, with laterals running both east and west from it. The northern group when completed had an irregular form, approximating the letter H. The south group comprised three main elements.

Of the 54 pits, all but two were in the area of the triangle. Small amounts of cultural material were found in the topsoil (i.e., that part which had been subjected to ploughing), and even a few artifacts, as already observed, but the greater portion came from the pits themselves.

In view of the confusion caused by overlapping, an analysis of the cultural remains square by square has been attempted. The gross recovery was 4248 pieces (exclusive of human remains), and of these, 1453 were artifacts. As evidence of the intensive occupation of this area, it may be pointed out that the "4"-trench held 26% of all pits opened, and yielded 58% of the gross total of specimens from the site, including 39% of all pottery. The remaining area representing 85% of the total explored yielded the other 42% of the cultural material. No other part of the excavation, not even the squares immediately flanking the "4"-trench were anything like as prolific as this. The situation in this trench may be seen in Fig. 3.

ANALYSIS OF REMAINS

Pottery accounted for by far the greatest amount of cultural remains (1416 specimens), with stone, bone and shell contributing very minor quantities each, to bring the total to 1453 artifacts.

Stone materials used by the Krieger site people included chert, a kind of slate, limestone, quartz and granitic rocks and sandstone. The chert is almost entirely a grey formation, often flecked and streaked, but a few examples of bluish chert are present. Mr. Charles F. Wray, of West Rush, N.Y., after examining a series, reported that it contained Onondaga flint, and probably also Lockport dolomite flint. It was always present in a worked condition, and all stages from roughly flaked pebbles through chips and rejects to finished projectile points and scrapers are represented. Out of 294 objects of this material to be excavated, 18 were finished artifacts or fragments thereof. This may indicate that some flint-working was done on the site, but more likely most of the artifacts were made elsewhere, since the ratio of chips to finished product seems low.

Of the slate objects found, five are chips and one appears to be a scraper. The source of the material is not known, but is probably local. It is rather coarse-

grained and grey with a dark reddish cast. In addition to the above, Mr. Wortner found a small piece of worked slate, probably from a bannerstone, in the spring of 1950.

Small nodules of limestone discovered in various parts of the site may have been natural occurrences.

A few fragments of a translucent white quartz were found as well as a number of nodules of a decayed or burnt granitic material. The quartz appeared to have been artificially fractured, but showed no sign that any attempt had been made to fashion it into anything. Its presence here, though amounting merely to a couple of pieces, is worth noting since it is of so common occurrence on Indian sites in Ontario and has not yet been satisfactorily explained for any occupation. The granitic material probably came from firestones, very few of which were saved.

A large number of pieces of sandstone (60) was found in camp refuse, but none appears to have been worked.

Since the soil in the area is remarkably free of stone, it appears likely that most of those found on the site had been brought there by the former inhabitants. All except the chert, and possibly the slate, occur locally and could have been picked up over a wide area; it is the concentration which indicates their transportation thither.

Somewhat more than one-half of all the material recovered from the Krieger site is in the form of bone. Samples of all types were saved, though considerable quantities were discarded due to the time factor involved in recovering it. Fish, mammal, bird and human bones are all present, and in that order in point of quantity, with also a few pieces of turtle shell. The great amount of this material indicates emphatically the dependence of this people upon these sources of food, particularly upon fish and mammal. The seeming preponderance of fish bones may however be deceptive for they preserve well and are in many species far more numerous than in mammals. Besides, most of them probably found their way into the refuse directly.

There are 555 specimens of mammal bone. This second largest segment of the bone inventory contains a wide variety of material, including representatives of white-tailed deer, raccoon, grey squirrel, black bear, muskrat and possibly elk. The first-mentioned appears to be the most abundant. Thanks are due to Mr. S. C. Downing, Royal Ontario Museum of Zoology, for the identifications given above.

Many of the remains, particularly the long bones, had been splintered (165 specimens), or splintered and burned (45). Another 23 specimens, not long bones, had also been burned. The remainder of the material is for the most part in a fragmented condition. There are 11 animal teeth and 9 artifacts of mammal bone, all in the form of awls.

Aside from providing clues to food sources, the bone inventory proves the presence of the dog. This is indicated by the presence of a tooth, and more emphatically by the finding of a skull by Mr. Wortner in 1950, identified by Mr. Downing. The variety is indeterminate.

There are 97 specimens of bird bone, mostly from small species, but including a turkey's leg bone. Twenty had been subjected to burning. No artifacts of bird bone were noted, unless it be an awl which was included in the previous category.

Thirty-three specimens of human bone not associated with burials were found in pits. The most striking find was in a square where two human femora lay crossed; their brownish, rather glossy condition suggests, though it does not prove, that they had been boiled. Most of the other bones were from hands and feet.

Eleven fragments of turtle plastron were recovered, but since none showed human workmanship, it is likely that their owners were used for food.

Snails and bivalves were the two shelled creatures whose remains (183 specimens) were found at the site. The former (31 specimens) probably arrived there through natural causes, since there is no evidence that they were used for food, and only one, a *Campeloma* shows any signs of alteration. This one is perforated on the lip as if for a bead—the only instance of a shell artifact at Krieger—and has the appearance of having been intentionally fashioned. All the forms are local.

There is no doubt, on the other hand, that clams of several sorts were gathered and eaten by the Indians. Sixty-eight entire valves, 66 fragmentary ones, 11 burnt pieces and 7 valves which showed alterations possibly due to human agency make up the inventory. Four varieties, all freshwater edible forms, are distinguishable, as follows:

Amblema costata Raf. (9)
Obonana subisturba liabii (Lea) (15)
Elliptis dilatatus Raf. (44)
Pleurobema coccineum Conrad (16)

The identifications of these as well as of all other shells were made by Dr. Harald Rehder, and Dr. Joseph P. E. Morrison, of the United States National Museum, to whom thanks are due.

The *Elliptis* is by far the most frequent at the Krieger site; 35 entire or nearly entire valves are present. Where breakage occurs on these, it is usually at a point opposite the muscle attachment, indicating that the bivalve was forced open while still living, presumably for the sake of its flesh. The same holds true for *Obonana* but to a lesser extent. *Amblema* is represented by 2 entire valves and 7 fragments; *Pleurobema* by 5 entire or nearly entire valves and 11 small fragments which usually include the muscle attachment. Its present distribution is from southern Canada to Missouri and Kentucky. It is evident that the shells of the latter two forms are much more broken for some reason than the others; perhaps they are more difficult to open. In any case, the evidence all points to the use of clams for food at this site (Fig. 4k).

The stone inventory is small. Material recovered during the excavation shows only 13 projectile points including fragmentary ones, four or five scrapers, a fragmentary drill and a blank for a pipe bowl, as well as three samples of ochreous material probably for use as pigment. In addition to these, Mr. Wortner's collection contains three projectile points, and a double-pitted anvil stone; and Mr.

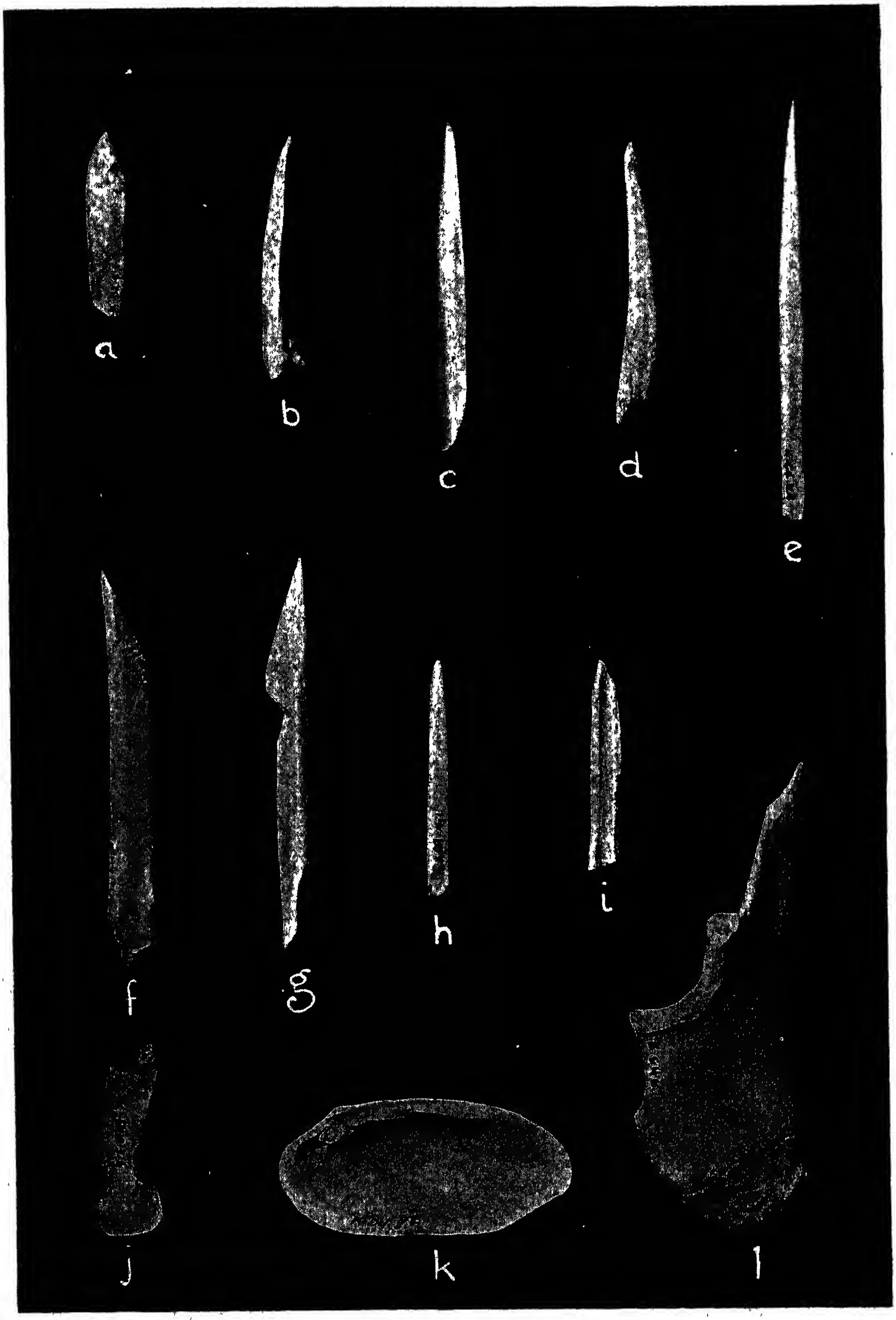

FIG. 4. Specimens of bone and shell: (a–i, l) bone awls; (j) altered metatarsal bone; (k) mussel shell. Specimen (l) is 3⅜ inches long, and the others in proportion.

Winberg's, 43 projectile points and fragments, six drills, four scrapers and one knife.

Of projectile points, four principal types have been found at the site; these with the total number of each are as follows: (1) unnotched, 22; (2) corner-notched, 13; (3) side-notched, 16; and (4) stemmed, 3 (Figs. 5a-o, 6). Fragments too small to classify number 8. Since most of these are surface finds, the question may arise as to what proportion of each was excavated. The answer is that the ratios hold for excavated material as well as for the general run; thus, unnotched points were found *in situ* to the number of 4, as well as one corner-notched and 2 side-notched specimens. No stemmed points whatever were found by the field party.

The most common variety may be described first. These points are usually triangular, and may have either a concave, straight, convex or irregular base. Of the excavated points, those with concave bases are in the majority, while surface finds had mostly straight or irregular bases (Fig. 5e,f). Triangular points tend to be roughly made and may be as large as 4.7 × 3.3 cm. Some, like that shown at (f) and Fig. 6 (b,c) have concave sides as well as concave bases, while others are straight-sided. One sub-type in the Winberg collection shows an extremely concave base, described best as "contracting" (Fig. 6a).

The corner-notched points were much more commonly found on the surface than in the excavation and therefore may not represent the type used by the people identified with the site. Such points are often broad leaf-shaped, and the notches at the corners may be small, regular and neatly-made; or so broad as almost to constitute the artifact a stemmed point (Fig. 6e-g,o,p). The excavated specimen, found at the bottom of a pit, belongs to the first sub-type with small notches (Fig. 5b); since it was definitely in an undisturbed deposit, the type is presumably contemporary with the occupation, but does not seem to have been popular with the people of the time. It was associated with a few chert chips, bone refuse and pottery (Fig. 7f).

Side-notched points constitute the third class, and here again with two representatives in the excavated material (Fig. 5a,c) both narrow leaf-shaped specimens. Almost identical points were found on the surface, eight being in the Winberg collection and one in the Wortner collection (Fig. 6j,k,m,n). Other variants are points with broad notches and irregular bases, and points with irregular notches and straight bases.

The stemmed point is represented by three specimens in the Winberg collection. They are evidently aberrant material, being quite different among themselves as well as from the excavated specimens (Fig. 6q).

Thus, out of 59 points and fragments of points found at the site, only 13 were obtained under controlled conditions. Of this small group, four are triangular, two are side-notched and one corner-notched. We must assume, then, that the triangular points were the dominant form at the time of the occupation, but that the side-notched and corner-notched varieties were also in use.

One specimen in the Winberg collection may have been a knife. In its broken condition, for the tip is missing, it measures 3.2 cm. in length; its general outline

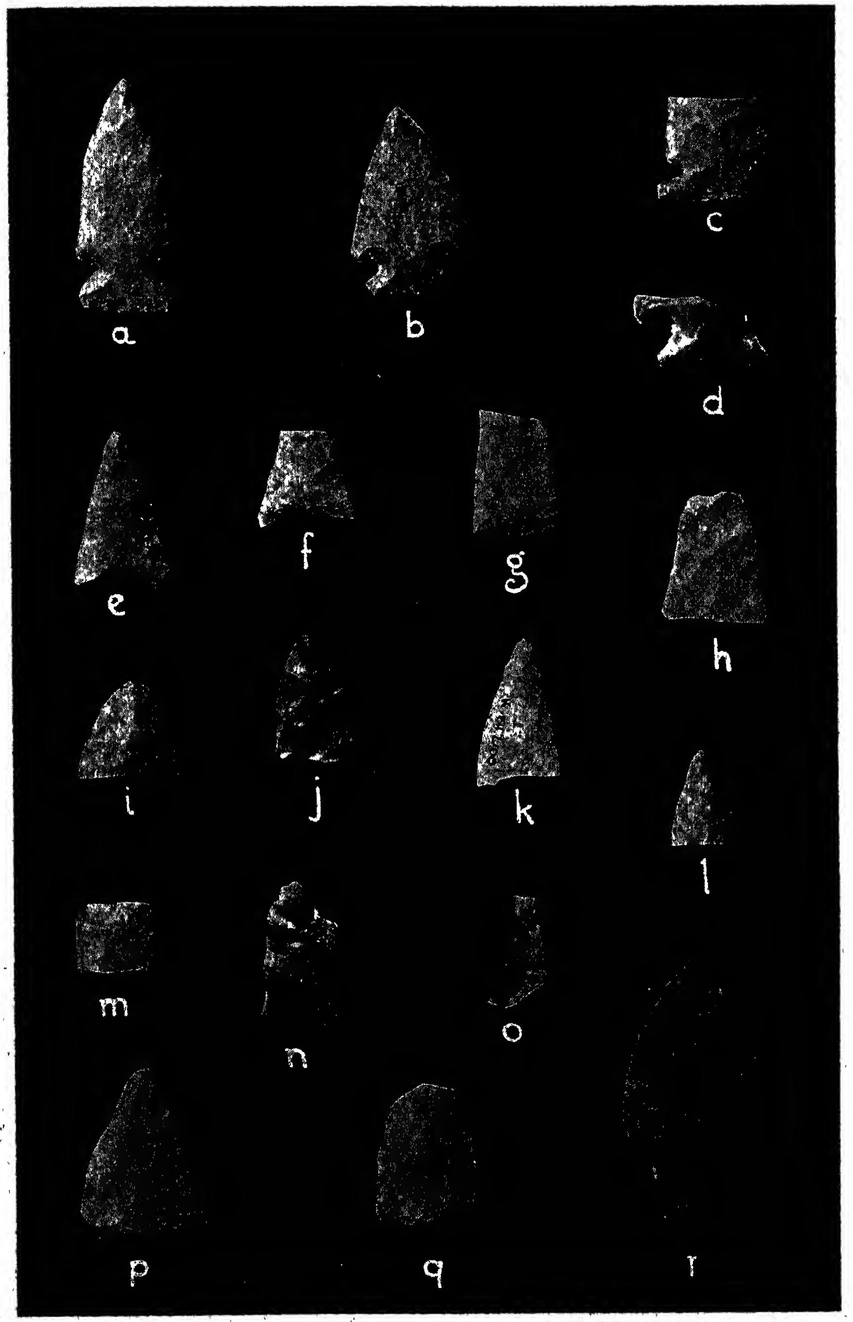

FIG. 5. Artifacts of stone: (a, c) side-notched projectile points; (b, d) corner-notched projectile points; (e) triangular, unnotched point; (f–h) fragmentary, triangular unnotched points; (i–l) fragmentary points of indeterminate shapes; (m, n, p–r) scrapers; (o) fragmentary drill. Specimen (a) is 1⅝ inches long and the rest in proportion.

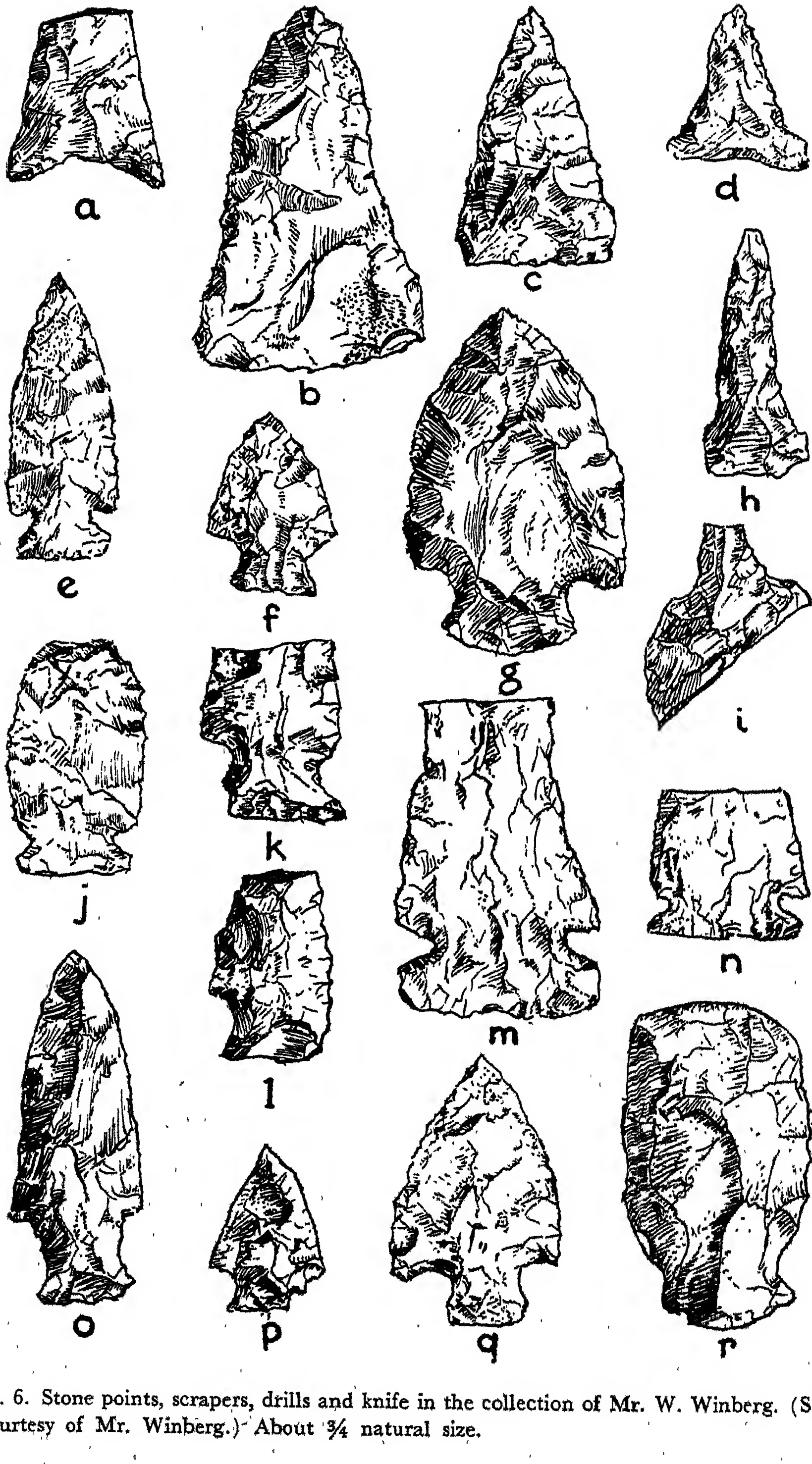

FIG. 6. Stone points, scrapers, drills and knife in the collection of Mr. W. Winberg. (Sketches by courtesy of Mr. Winberg.) About ¾ natural size.

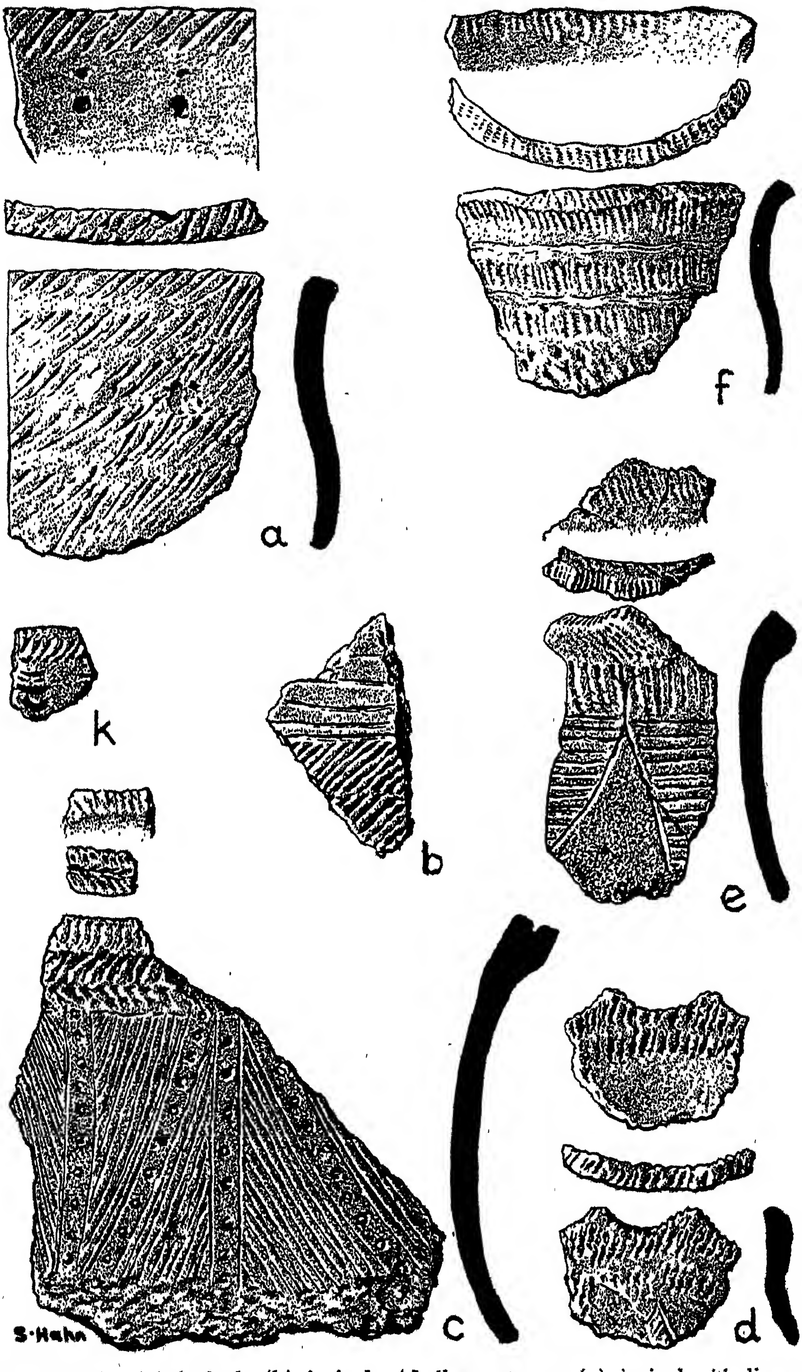

FIG. 7. Sherds: (a) incised; (b) incised with linear stamp; (c) incised with linear stamp and punctation; (d) incised with pseudo-scallop shell, and castellated; (e) incised with dentate stamp; (f) incised with cord-wrapped stick; (k) incised with punctations. All from the excavations, except (c), which is in the Wortner collection. About ¼ natural size.

is leaf-shaped with a straight butt; one side is convex and unnotched, the other has a notch at the corner (Fig. 6 l).

As before mentioned, only one fragmentary drill was excavated, and it appears to have been the expanded form (Fig. 5o). It was found at a depth of 30 inches in a pit. The only other drills are in the Winberg collection which contains six. Four of these are similar to the excavated specimen, one is Y-shaped and one had a round head (Fig. 6d,h,i).

Of the three end scrapers excavated, two are rectanguloid (Figs. 5m,n,q; 6r) and one trianguloid (Fig. 5p). While these implements are made from a grey chert, a fourth tool, taken to be a scraper also, is fashioned from slate (Fig. 5r). It is much larger than the others and shows much wear along the convex side. The Winberg collection contains a fragmentary red slate scraper and three notched ones.

An extremely soft piece of whitish limestone was found in the fifth level of a pit and has the appearance of a blank for a right-angled pipe. It has been partially pecked into shape and the bowl bears a cylindrical form, but the base or stem is indefinite. The dimensions are 5.5 $\times$ 4 $\times$ 3.6 cm.

A double-pitted anvil stone in the Wortner collection is 9.8 $\times$ 6.8 $\times$ 3 cm. The sides show some abrasion.

Three pieces of yellow ochreous material were found in pits and may possibly have been used as pigments, since they would lend themselves naturally to that purpose.

A small fragment of rubbed slate about 1½ inches in diameter and more or less triangular was probably broken from a butterfly stone. It was found on the site in 1950 by Mr. Wortner.

The number of artifacts made of bone is even smaller than that of stone, but they were present in all parts of the excavation and at various depths.

Ten of the specimens are awls (Fig. 4a-i,l). One pair consists of two catfish spines, found in different pits at the fourth level (Fig. 4b).

There are three splinter awls of varying lengths, all well finished and polished throughout, and all possessed of sharp points. The longest—a slender tool—has a slight constriction near the proximal end which seems to be intentional (Fig. 4e).

The medium-sized specimen is faceted lengthwise where it has been rubbed into shape, and is very sharp. One facet is so highly polished as to suggest it may actually have served as a polishing tool in some connection (Fig. 4c). The smallest of the three is highly polished but probably only a fragment of a larger specimen (Fig. 4a). A fourth splinter awl is much larger than those just described (Fig. 4g); it is made from a large mammal leg bone, probably of the deer, and is finished only towards the point, which is sharpened abruptly. A scarf just above the point cuts back deeply into the shaft, and raises the question of whether the specimen may have been an awl at all, but intended rather for a point for a leister or a harpoon. Two other awls (Fig. 4f,i) are made from segments of bird bone; the latter has a short but very sharp point. The last and largest awl has been prepared from an ulna of an immature deer whose epiphyses had not united. The shaft was cut abruptly to make a very short but sharp

pointed instrument (Fig. 4 l). A large awl similar in general shape to the last, in the Wortner collection, was made from a splinter of mammal leg bone and is 11.3 cm. long. Finally, a shorter but similar tool, 9.3 cm. long, is in the Winberg collection.

One deer metapodial is probably worthy of mention, though it seems not to have been worked (Fig. 4j). Finally, a piece of human skull, about 2.5 cm. square, was found on the site by Mr. Wortner in 1950. It shows staining due to the effect of leaching in ashes and a small scorched patch on one broken surface. More interesting, however, is the presence of part of a drilled perforation, which had been done with an instrument .5 cm. in diameter, and gone completely through the bone.

Ceramic remains, which loomed so large at this site, will be discussed in the following section.

Ceramics

Krieger pottery may be defined as fine-tempered, i.e. the aplastic is present in large quantities, but consists for the most part of small grains of quartz-like material, while in a few sherds larger grains, some as much as 5 mm. in diameter, occur. In about 12% of all sherds, aplastic material accounted for nearly one-third of the mass; in the remainder the ratio was much less. The texture of Krieger pottery is, generally speaking, poor. Despite the predominantly fine aplastic, the ware is full of bubbles and air holes, porous and rough in aspect. The most striking characteristic of Krieger ceramics, however, is the decoration. Very few pots and apparently only the smallest, were left plain. All others were profusely decorated on the upper portions and usually textured on the body. All but twelve rim sherds and 309 body sherds excavated had some form of decoration.

Table to show Incidence of Decoration and Surface Treatment

Body sherds (a) Plain	309		
(b) Textured (fabric)	704		
	——	1013	
Rim, neck and shoulder sherds, decorated. Total . .		437	
		——	1450
Less duplicated			34
			——
Total			1416

It was upon the necks, shoulders and rims of vessels that the potters lavished their greatest attention (Figs. 8,9). Techniques were limited enough, comprising only the use of incising, stamping, the cord-wrapped stick and punctation, but the first was employed both singly and in combination with each of the others and the last three illustrate within themselves the use of a considerable variety of instruments of different shapes, sizes and patterns. A word of explanation upon each of these is in order.

About 30% of body sherds and a small number of rim sherds were left smooth and plain, and entirely undecorated. On the remainder the bodies were treated

FIG. 8. Two restored vessels: *left*, from the Museum excavations, showing linear stamping on the rim and upper neck, exterior and interior, incising in two styles on the shoulder and heavy body texturing, and five castellations; *right*, from the collection of Mr. N. Coppieters, with design made with cord-wrapped stick, and coarse body texturing.

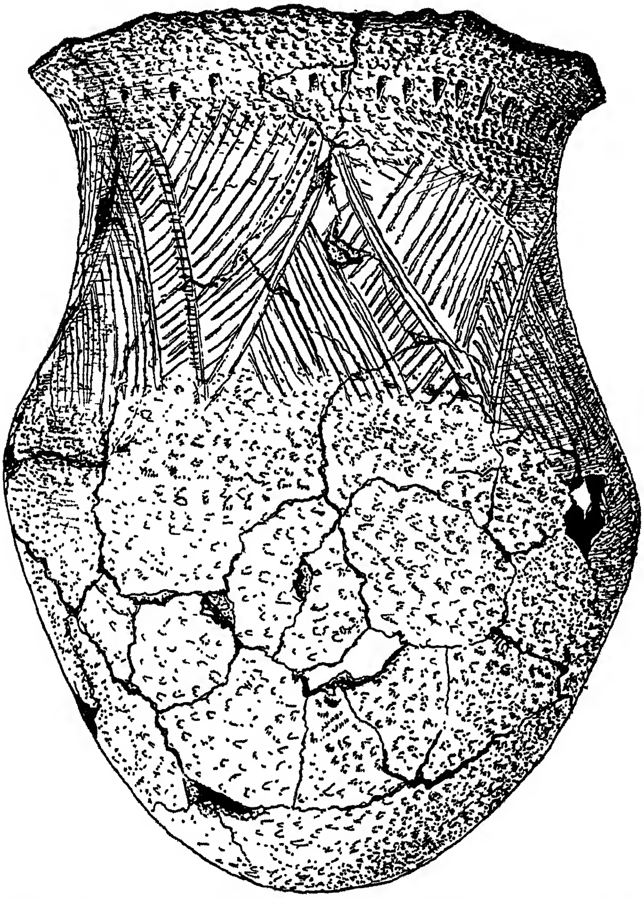

FIG. 9. Vessel excavated and restored by Mr. John Gazarek and now in the Kent-Chatham Museum at Chatham. Height: 19 inches. (Courtesy of Mr. Gazarek and the Kent-Chatham Museum. Sketch by Mr. W. Winberg.)

by texturing with some material, probably coarse textiles; frequently the resulting surface was partially smoothed, leaving it only slightly textured and with the pattern largely obliterated. A very coarse material was used for texturing in many instances, apparently being applied to the same surface first in one direction and then in another, with the result that the surface is greatly roughened and the pattern largely destroyed (Fig. 8, *right*). This texturing is applied only to the body exterior; the neck exterior and the interior are never so treated. They are smoothed. The neck and rim and sometimes the shoulder are smoothed to receive the decorative design. In some instances, however, the applied decoration overlaps the surface treatment on the body; this is especially common in the case of incising (Fig. 9).

Decorative techniques, as already mentioned, comprise (1) incising; (2) stamping; (3) cord-wrapped stick or paddle-edge imprinting; (4) punctation and certain combinations of these. In all cases, the resulting design was a com-

posite affair, made up, in the case of incising, of an arrangement of straight lines scratched in the wet clay, and in the case of stamping by the repeated application of a stamp in such a way as to result in an overall pattern. The same applies to punctation and the use of cord-wrapped stick, although from the small sherds of the latter available for study, the construction of patterns seems to have been limited. The exception to the rule is to be found in the case of complex stamps in which the pattern is often simply built up by repeating the impression in a zone or band to form one continuous pattern.

Incising

This technique was freely and abundantly used in decorating Krieger pottery. It was applied to shoulder and neck commonly, less so to the rim and its interior. Two hundred and twenty-seven sherds or 49% of all rim, neck and shoulder fragments are so decorated. Among these are rims of five vessels, of which two exhibit incising on the interior; one is plain and the other exfoliated on the inner surface. On all five, incising was applied to the exterior neck and rim. Incising is more common on the neck, where it reaches its greatest florescence. It takes the form chiefly of hatched triangles so arranged as to leave plain triangles between; cross-hatched triangles similarly arranged; triangles hatched in opposite directions; and large rhombi broken up into small triangles hatched as in the last instance, and hatched rectangles, usually outlined by a plain border. Such units as the large rectangles and rhombi are generally, but not always, also emphasised by an incised line forming a border around them. In a few cases, horizontal incised lines are placed to encircle the necks of vessels, where they either serve as decorative elements in themselves or to separate other decorative elements. One vessel is decorated exteriorly and on the rim with short, diagonally placed incisions closely spaced; interiorly it has a row of bosses, each about 5 mm. wide and 4 cm. apart running horizontally around the neck and 4 cm. below the rim. From the outside these bosses are not conspicuous. The incising is characterised by crude workmanship; the lines vary in depth, the spacing is generally irregular, and many over-run the plats or triangles within which there was an obvious intention to confine them (Fig. 10 l,m). In a few instances, indeed, the incisions carry down into the body texturing a short distance, and again, lines do not end at the confines of a triangle, or fall short of them. It is seldom that a fine, carefully executed design is to be seen in this technique. As for the width of the incisions, both fine- and wide-line styles are apparent, the former being about 1 mm. and the latter as much as 3 mm. wide, i.e. a form of trailing.

There are 37 sherds bearing incising in combination with other techniques, which may be subdivided as follows:

(*a*)	Incising plus linear stamp	5	sherds
(*b*)	" " dentate stamp	12	"
(*c*)	" " complicated stamp	7	"
(*d*)	" " cord-wrapped stick or paddle	2	"
(*e*)	" " punctation	6	"
(*f*)	" " linear stamp plus dentate stamp	1	sherd,

(*g*) Incising plus linear stamp plus punctation . . . . . . 4 sherds
These may be briefly described to give an idea of the manner of arrangement, leaving details of the non-incised techniques for inclusion under the proper heading.

(*a*) *Incising plus linear stamp.* In three instances the incising consists of a zone of horizontal lines, bordered at one side by a continuous linear stamp design (Fig. 7b); in one the linear stamp forms a continuous border at the rim (Fig. 7c); while in the fifth specimen hatched plats of incising are bordered by a band of linear stamps. The vessel illustrated in Fig. 8, *left*, which has been classed as an example of Krieger Incised, bears a zone of linear stamping on the rim, both interior and exterior. The shapes of the stamps vary somewhat.

(*b*) *Incising plus dentate stamp.* One specimen showing hachured triangles of incising is bordered by a series of horizontal lines of dentate stamp impressions. A second has a band of dentate stamping bordered by incised lines horizontally placed. Two small sherds, of thinner ware than any of the above, appear to have a triangle and horizontal lines of incising bordered, in one case at the rim, and in the other on the shoulder, with a double or triple band of pseudo-scallop shell stamping (Fig. 7d). In cases where the rim is intact, the same design is present on the interior. A large sherd from another vessel has hachured and incised triangles on the neck alternating with plain triangles of the same size, with bases and tips at shoulder and rim; the rim is decorated with a zone of vertical dentate stamps below and obliquely placed ones above. The interior rim has the same stamped design bordered below by a row of punctations (Fig. 7e).

(*c*) *Incising plus complicated stamp.* In the case of the largest sherd, comprising somewhat more than half the rim and neck of a small vessel with an oral diameter of 11 cm., roughly incised horizontal lines are utilized to mark off two zones of dentate-stamp-like impressions on the neck and a similar design on the rim; the top and inner margin of the rim are decorated with the same stamp (Fig. 7f). One other sherd shows a band of three incised horizontal lines used to separate a zone of complicated stamping on the neck from a complicated stamp, very much resembling pseudo-scallop shell only much coarser, on the rim (Fig. 11g). In two other sherds oblique hatched lines occur below a band of complicated stamping on the rim, and another has hatched triangles of incising below (Fig. 11h).

(*d*) *Incising plus cord-wrapped stick.* In one shoulder sherd, the cord-wrapped stick was used to mark two parallel, horizontal lines on the shoulder; incising was placed crosswise of this in a rough hachure, both the incising and the cord-wrapped stick impressions being laid on over the body texturing (Fig. 11i). In another example, opposed triangles are filled with lines of cord-markings and outlined by incised lines (Fig. 11j). Four sherds, probably all from the same vessel, show a band of horizontal incised lines bordered between shoulder and body by a wide band of oblique impressions forming a continuous design. Four other specimens are decorated on the neck with incised and hachured triangles bordered at the rim with a zone of obliquely placed cord-wrapped stick impressions (Figs. 10 l, 12:4). The vessel shown in Fig. 8, *right*, also bears a cord-wrapped stick decoration on the rim.

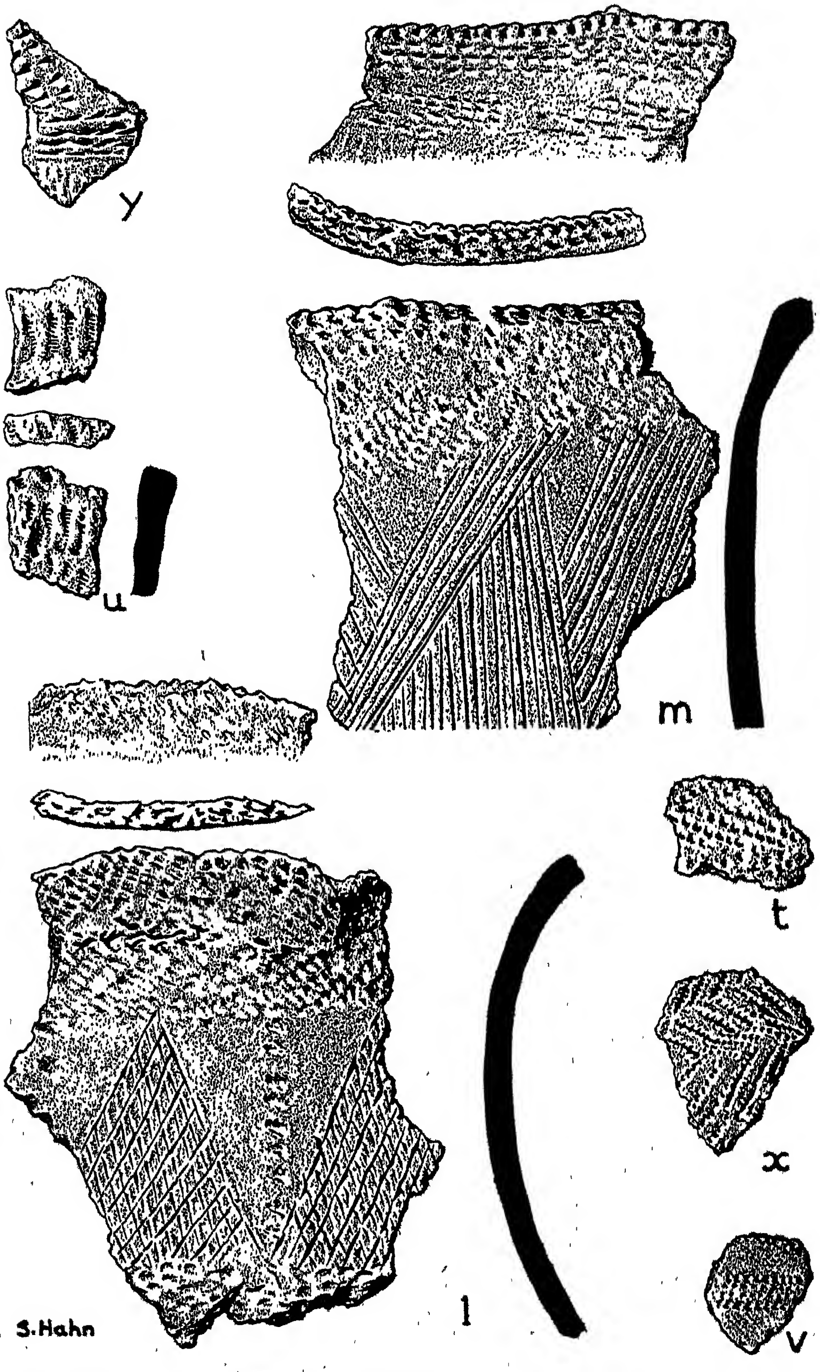

FIG. 10. Sherds: (l,m) incised with punctation and cord-wrapped stick; (t,v) stamped; (x) cord-wrapped stick; (u, y) punctate. All from the excavations except (m), which is in the Wortner Collection. About ¼ natural size.

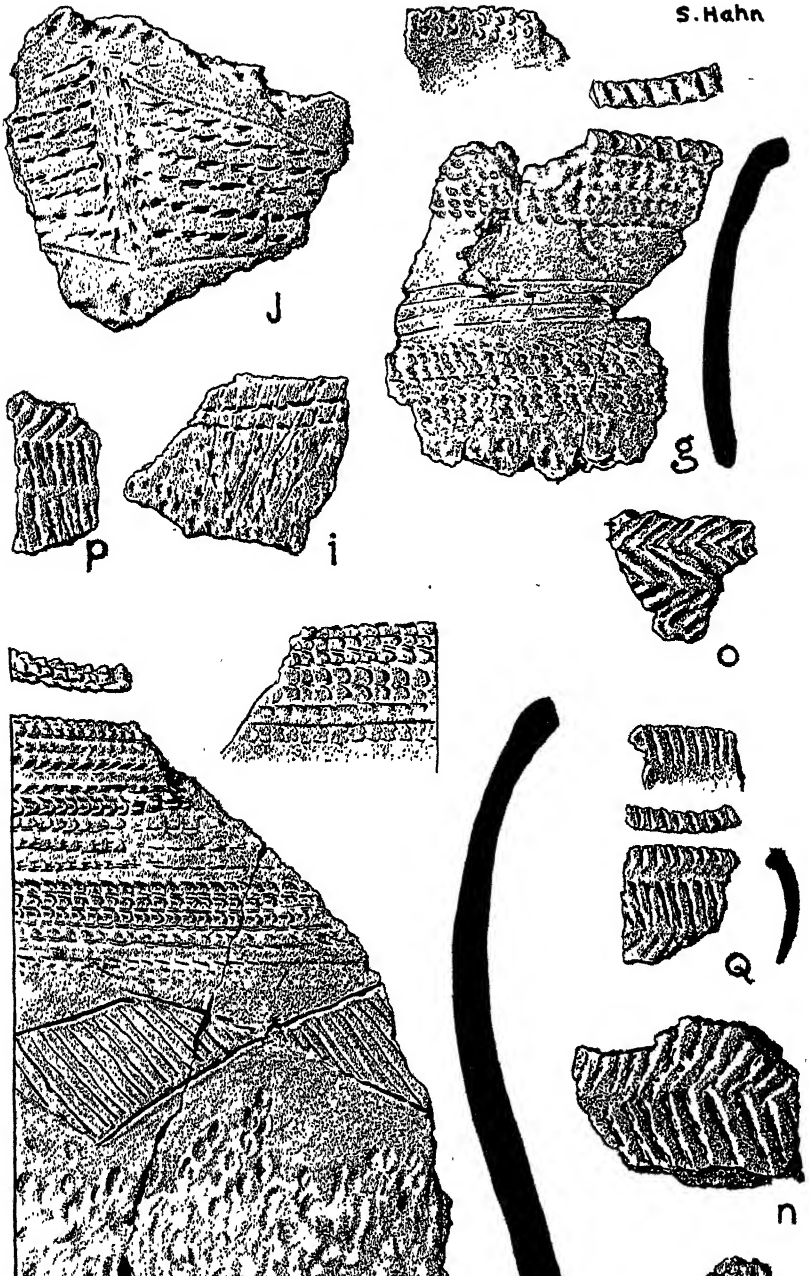

FIG. 11. Sherds: (g, h) incised with complicated stamp; (i) incised with cord-wrapped stick; (j) linear punctate; (o–r) linear stamped. All from the excavations except (h), (j), and (n), which are in the Wortner collection. About ¼ natural size.

FIG. 12. Sherds from the surface and other collections: (1) large rim sherd showing design of concentric rhomboids done in dentate stamping; (2) complex design in incised technique with cord-wrapped stick decoration on the rim; (3) small vessel with incising and punctation; (4) vessel with cord-wrapped stick decoration on the rim and incising and punctation on the body. Courtesy of Messrs. Coppieters and Wortner. (About ¼ natural size.)

(*e*) *Incising plus punctation.* Two sherds probably from one vessel bear incised and hachured triangles, one of whose borders is indicated by a line of short, straight punctations. One small vessel bears horizontally incised lines bordered on the rim by deep vertical punctations (Fig. 12:3). In another sherd, a hachured area is bordered on the shoulder side by a row of small punctations. Two small sherds bear what suggest incised and hachured triangles over a pattern of small crescentic punctations (Fig. 7k). A line of more or less triangular punctations has been applied over cord-wrapped stick decoration on the rim of the vessel shown in Fig 9.

A small number of vessels was decorated with designs made by using incising combined with two other techniques, as:

(*f*) *Incising plus linear stamp and dentate stamp.*

(*g*) *Incising plus linear stamp and punctation.*

Incised and hachured rectangles, separated by a plain strip, are bordered at the shoulder by a linear stamp impressed to create a chevron pattern. The punctation occurs in the form of impressed circles equidistantly placed within otherwise plain bands which cut the hachured rectangles into triangles (Fig. 7c). This

pattern is exemplified on three sherds from one vessel. A large sherd showing rim, neck and parts of the shoulder is decorated on the neck with cross-hatched and incised triangles with the bases on the shoulder. Between these, on the plain areas, is a vertical line of ovoid punctations. The rim is decorated with a variety of cord-wrapped stick impressions (Fig. 10 1). Another example shows roughly incised triangles with punctate bosses arranged in a row above, and bordered with pseudo-scallop shell stamping.

Stamping

Next to incising, this technique was the one most commonly used at Krieger. Indeed, if it does not enjoy a straight numerical majority, it was probably even more lavishly used than any other, in the sense that it occurred on many vessels which were also incised, was used in a variety of ways, one stamp being combined with another, and in numerous forms. The principal forms of stamps used, with the number of sherds of each, are: Linear (35); Dentate (28); Complicated (56) and Miscellaneous (7). There is no example of rocker stamp whatever at this site.

In the following description of stamped designs, the above count indicates those sherds which have stamping only. Others have already been described under Incising.

(*a*) *Linear stamp.* The linear stamps used at the Krieger site were simple affairs, being long rectangles, or in some cases ovals. Some were impressed deeply, others shallowly; some were widely spaced, others closely (Fig. 7b). They were usually applied in series to produce a band of continuous design. Single bands of this sort occur on one rim and six shoulders. A popular arrangement was to impress the stamp into a chevron pattern, either single or multiple; two rims and six shoulders are so decorated (Fig. 11o,q,n). Many sherds (5 rims, 12 necks, and 1 shoulder) are decorated by parallel bands of linear stamp impression, either contiguous or separated (Figs. 8, *left*; 11p; 13s).

Some of these impressions are shorter and broader (Fig. 11r), others are deeper at the ends than at the middle, while one at least resembles a cord-wrapped stick. Occasionally in multiple stamping the direction of one band will be changed to produce a chevron at the edge (Fig. 11p). There is only one instance of such a stamp being arranged in a vertical row; this occurs on a small rim sherd also bearing a horizontal band.

(*b*) *Dentate stamp.* Dentate stamps occur in quantity and some variety. Many appear to be multiple impressions while others are certainly made by one stamp capable of impressing several rows at a time (Fig. 10v). Two arrangements prevail. The first is a banded zone, usually horizontally placed, in which the design runs continuously around the vessel. The impressions may be arranged in the band vertically or obliquely (Fig. 13w); a conspicuous example was described under Incising (*b*) (Fig. 7e). The second is a herringbone arrangement found on three necks and one rim sherd (Fig. 10t). A more striking arrangement found on two vessels comprises the arrangement of dentate stamps into concentric rhombi on the shoulders and bordered by linear and zoned stamps (Fig. 12:1). The total number of sherds in this class is 28.

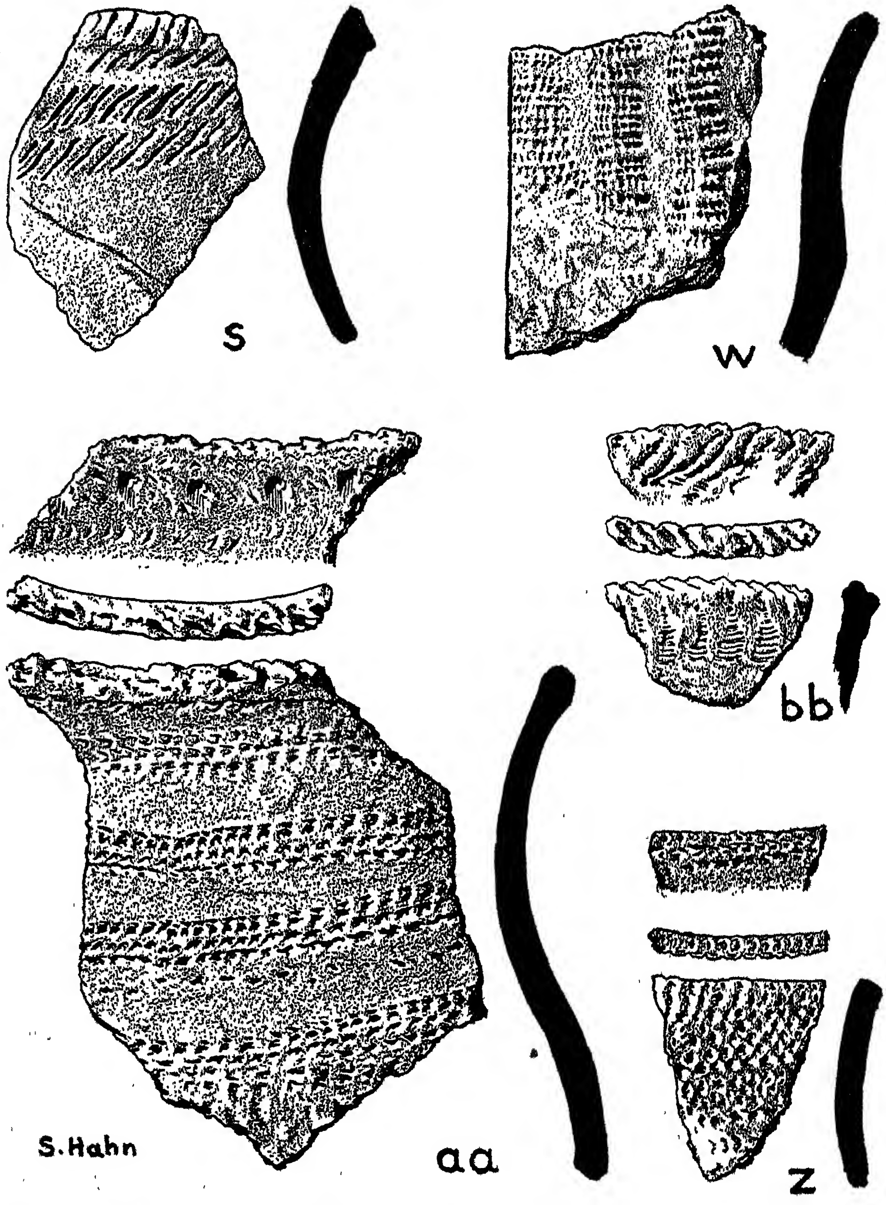

FIG. 13. Sherds: (s) linear stamped; (w) cord-wrapped stick; (z, aa) complicated stamped; (bb) stamped. All from the excavations except (w) and (aa) which are in the Wortner collection. About ¼ natural size.

One more simple stamp for which it is unnecessary to set up a separate classification uses a small triangular pattern of three or more oblique, parallel lines on the neck. The work could, if great care were exercised, be done equally well by punctation. (Fig. 10y).

(*c*) *Complicated stamp.* A large number of rims (both exterior and interior), and necks are decorated with complicated stamp impressions some of which are as much as 4.5 cm. wide (Fig. 11h). Most of them suggest basketry impressions but latex casts do not indicate any known basketry weave (35 neck and 21 rim sherds including two rim sherds from the same vessel and one rim exfoliated on the interior) (Figs. 11h, 13z,aa). The designs, to judge from the mostly small sherds available, are composed similarly to the dentate; i.e., by arranging two parallel bands of elements. It is also evident that complicated stamps, like the dentate, are combined with other techniques to constitute a design; as when it is used in combination with incising; in such cases the stamped element is restricted to the rim and incising to the neck (Fig. 11h). As for rim interiors, they are decorated in all 14 cases where they are intact; only six, however, have identical patterns on both sides, the other eight having complicated stamp designs on the interior which are slightly different, usually simpler, than on the exterior; in two instances the interior has pseudo-scallop shell impressions.

(*d*) *Miscellaneous stamp designs.* Seven sherds show stamp designs which do not fit into any of the above categories. The most interesting are three sherds, possibly all from one vessel, which exhibit on the exterior rim a band of small triangular impressions which are striated crosswise, very much in the mode of the so-called "snow-shoe" pattern seen on Maple Ovoid Stamped pottery, described by Griffin in "Some Early and Middle Woodland Pottery Types in Illinois", p. 112 and Pl. XXXIV, AE. The interior rim of these is decorated with a similar band, in which the impressions appear to have been made with the stamp held at an angle to the surface rather than flat as on the exterior. The work is always applied to a plain surface (Fig. 13bb).

Cord-wrapped stick. One vessel (Fig. 8, *right*) and twenty-one sherds, including one which appears to be aberrant at the site, exhibit this type of decoration. The aberrant piece has a hard paste, is smoothed inside and out, has a flattened rim bevelled on the outside, whose only decoration consists of a band of obliquely-placed cord impressions on the bevelled face of the rim. The other sherds, all from shoulders except one rim piece, bear impressions of cord or cord-wrapped stick or paddle-edges arranged between the body-textured area and the upper portions of the vessel; there may be from one to two or three such lines, and in one case they are also arranged in a triangular pattern, or at least so as to converge (Figs. 7f, 11 l, 10x). The latter equates with "Owasco Herringbone" (Ritchie and MacNeish, 1949, pp. 110–11). Cords used for such impressions varied from 2 to 4 mm. in diameter, and all appear to be single-twist, and since few if any fibres appear, most of them must have been made with twisted sinew.

Another form of cord-wrapped stick impression is so close to dentate stamping as to be scarcely distinguishable from it; it may in fact have been produced by impressing a stick strung with small berries or seeds, for spiralling is not evident. It tends to be heavy and coarse, and the impressions often blurred by partial smoothing. (Fig. 10 l, upper decoration, m; 12:2, 4). If it has been done by a method cognate with Ritchie's "pointillé" work, it is very unlike it in effect. The style is common, occurring on a total of 48 sherds, including eight rims. On all the interiors of the latter, except one which has exfoliated, the same

design occurs as on the exterior. The sherd described under Incising (g) and having the cross-hatched triangles (Fig. 10 l) is in this class.

Punctation

This is for the most part simple, comprising only a crescentic punctation such as might be obtained by using a hollow reed held at an angle to the surface of the vessel (Figs. 7a, 10 l, 12:3, 4). One punch was a rectangular affair, possibly of wood. Pattern is usually achieved by arranging the individual marks in parallel rows on the rim and neck, either closely or widely spaced. In one instance, they are arranged into vertical and parallel rows on the neck, with the rims of the vessel decorated with dentate stamp. In two rim sherds, in this category, the rim is broad and flat; one deeply sulcated (Fig. 7c). The same design appears on the exterior and interior of both. Punctation was used in moderation, being found on only ten sherds, including the six which combined this with some other technique. An example of "corded punctate" is shown in Fig. 10 (u), while a linear punctate may be seen in Fig. 11(j).

Plain

In addition to the above, there were eight plain sherds in the collection, five of which probably came from diminutive vessels, and no doubt were the result of attempts at potting done by children, or intended as toys. On the largest of these, which represents about one-third of the entire vessel, corrugations indicative of coiling are apparent, but the modelling is crude and the shape irregular. Two of the other sherds reveal a laminated structure, as if built up by the paddle and anvil method. While it is possible that entirely plain vessels of ordinary size were made, none has been found. The dominant tendency was for vessels to be decorated and decorated lavishly. Plain areas, if tolerated at all, were generally used as foils for some sort of decoration.

Decoration ranged all the way from exceedingly bold to rather fine work. The techniques of stamping and punctating were handled with assurance and skill; if we concede that some of the very complex designs were made by stamping, the mastery of that technique by these people must also be admitted, for it is unsurpassed for regularity, complexity and diversity, so much so indeed that it looks at times surprisingly like some sort of textile or basketry impression (Fig. 11h). Incising, on the other hand, is by comparison cruder, more hesitant, less skilful (Fig. 11h). Despite this fact, however, it is present in nearly half of all decorated sherds, comprising by far the most consistent technique represented at the site. It seldom stands alone, but is combined on nearly every sherd with one or other of the other three techniques. Just as in the case of the latter, it occurs in a multiplicity of forms, the chief of which are hatching, outlines to plats, zigzags and triangles. The mastery of the techniques of stamping and punctating combined with the hesitancy of the incising on this pottery immediately bring to mind the same combination of characteristics reported by Ritchie for Castle Creek (Ritchie, 1944: p. 41, and Pls. 17–21).

With the exception of a single case where a simple curvilinear design occurs

on the interior of a rim, only rectilinear designs are employed. It sometimes happens also that in the complex stamped designs, the impression is not quite straight (Fig. 13aa) suggesting that a flexible stamp of some sort was responsible for the inconsistency. Neither situation invalidates the statement that designs at the Krieger site are emphatically rectilinear.

Due to the extreme diversity of individual patterns, and the range of combinations of techniques, great difficulty has been experienced in classifying the Krieger pottery. It was seldom that two vessels were made with exactly the same decoration and done by the same method; yet it sometimes happens that the same decoration exists on two vessels but done in different techniques. Thus, there occur on some sherds rhomboidal plats done by the stamped technique and outlined by incising, and filled with incised hatching; in others, similar plats were outlined by incising but filled with hatching done by impressing a cord-wrapped stick (cf. Fig. 11 h,j). Or again, linear designs occur which have been executed variously in incising, dentate stamping and with cord-wrapped sticks (Fig. 7a,e,f). It is for these reasons that techniques have been taken as the basis of classification. The rather small total of sherds, however, has made it inadvisable to classify the Krieger pottery in great detail, and at the present time it seems best to establish only two principal types—Krieger Incised, and Krieger Stamped, as below.

Krieger Incised. (Figs. 7a,c,e; 8, *left*; 9; 10 l-m; 11h; 12:2–4.)

Inventory: 37 rim and 193 body sherds; 2 restorable vessels (including surface and excavated material).

Paste: Temper—fine quartz.
Texture—usually coarse, with air bubbles, and crumbly.
Colour—light grey to light brown.

Surface finish: body either smoothed or impressed with fabric, coarse or fine.

Form: Rim—vertical to markedly everted. Usually has numerous weak castellations.
Lip—usually outsloping.
Neck—usually long and slightly concave; a few are straight.
Bodies—small vessels are semi-globular with subconoidal bottoms; large vessels presumably similar.

Size: Oral diameters range from 4 to 36 cm. with the majority from 20 to 36 cm. Only vessels decorated with a combination of incising and punctation show oral diameters of less than 18 cm.

Decoration: Rectilinear incising, either alone or combined with punctation, stamping, or cord-wrapped stick. The simplest forms consist of several rows of short, slanting incised lines around the neck and a combination of horizontal lines with punctation above. One piece shows a chevron incised pattern combined with linear stamp. Hatched triangles, arranged so that the lines in one are at a sharp angle to those adjacent; or separated by smoothed bands containing circular punctates are not uncommon. Various other arrangements of triangles occur. The accessory techniques are gen-

erally used to decorate the rim exterior, above the incised portion of the vessel; this zone may be quite wide. They are employed less commonly below the incised area.

Rim exteriors are almost always decorated and often in the same technique as that used on the exterior of the same vessel. Nodes occur on (i) sherds with incising and (ii) on sherds with incised and stamped designs. They are arranged in a line below the rim, either exteriorly or interiorly.

Krieger Stamped. (Figs 7f; 11g; 12:1; 13s,z,aa,bb)

Inventory: 62 rim and 102 body sherds; 1 restored vessel.

Paste: Temper—predominantly fine but sometimes containing larger amounts of coarse quartz grains. A few sherds show limestone tempering.

Texture—almost always coarse, but somewhat finer than *Krieger Incised.*

Colour—predominantly light brown.

Surface treatment: cord or fabric impressed on body, rim and neck smooth.

Form: Rims—slightly everted. Pronounced castellations on two sherds; weaker castellations on 13 others; usually but not always widely spaced.

Lips—outsloping.

Necks—usually long and straight, or slightly concave.

Bodies—semi-globular.

Base—the one entire vessel has a rounded base.

Nodes—both interior and exterior, one sherd possessing both types. Arranged in horizontal lines.

Size—oral diameters range from 12 to 36 cm.

Decoration: Rims, necks and shoulders decorated with impressions of linear, dentate and complex stamps. The linear and dentate forms are often arranged into rectilinear patterns, such as concentric squares or rhomboids, or they may be confined to simple bands. The complex stamps are impressed either to form an all-over pattern, or in bands on the rim, neck and shoulder. Rim interiors are almost always decorated with stamping, and often the same instrument is used inside and outside.

The dentate type is possibly sufficiently common to be given a classification of its own, such as *Krieger Dentate Stamped.* The same is true of the complicated stamped, but until the evidence is corroborated from other sites it has been decided to leave the terminology as inclusive as possible.

Clay Pipes

Considering the small total inventory at the Krieger site, the number of clay pipes and pipe fragments is large. One complete pipe, fragments of eight bowls and ten whole or broken stems were excavated, besides which there are in the Coppieter's collection one completely restored pipe and one bowl, and in the Winberg collection one stem. With one exception, all are consistent in style; usually have very little tempering material, a warm grey colour, and are either fine-textured, hard and well-baked or more inclined to be coarse and soft. Form

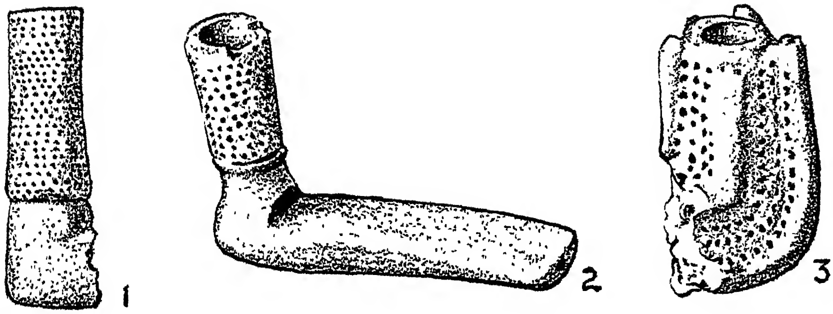

FIG. 14. Clay pipes: (1) from the excavation; height, 3½ inches: (2) restored pipe in the collection of Mr. N. Coppieters; length, 3½ inches; (3) pipe bowl in the collection of Mr. S. Wortner; height, 2½ inches.

and decoration are also consistent, and are best illustrated by the completely restored specimen (Fig. 14:2).

This is an elbow-shaped pipe, nine centimeters long with a cylindrical bowl 6.7 centimeters high and a diameter of 2.2 centimeters. Where bowl and stem join there is a slight constriction of the neck. The stem is plano-convex, flat side uppermost, curves downward and tapers somewhat toward the lip. The only decoration occurs on the bowl which has been marked with a series of round punctations applied by means of a roller stamp. A latex cast indicates plainly that the punctations are arranged in equidistant, straight rows horizontally. An incised line below demarcates the design area. An almost identical bowl was found in the excavation, the only difference being that the latter was taller (8.2 cm.), appears to have been a right-angled type, lacking the nubbin at juncture of bowl and stem, and was decorated with greater care. The incised line is lacking, the sole decoration being the rolled stamp design. In this case, the punctations are smaller, but more numerous and were laid on by two applications of a small roller, 2.5 cm. wide, one above the other (Fig. 14:1). Four other bowls belong in the type just described, but the punctations have been made by punching a stick irregularly into the surface. Three of the remaining specimens show irregular over-all punctation, circular punctations arranged in panels separated by vertically incised lines, and panels of simple punctations separated by plain areas only. Another, also of the cylindrical type, is decorated only on the lower part, which expands somewhat and bears a faint design of incised chevrons. The last specimen may have had a globular bowl, with constricted neck and flat, everted rim. Another fragment consisting of portions of bowl and stem is right-angled, somewhat similar in shape to the second specimen described above, and had three deeply incised horizontal lines around the bowl in a ring effect, quite unlike the general usage at this site. Since this aberrant specimen was found in the tilth, it is probably later than the rest of the material.

A very unusual bowl in the Wortner collection is shown in Fig. 14(3). A right-angled pipe, the bowl is basically cylindrical and decorated in the punctate manner, but to this have been added five vertical elements equidistantly spaced

around the outside. Each element is square in section and left plain. The two at the far side of the bowl continue down and along the bottom, two continue to the upper side of the stem, and the fifth meets the top of the stem in the middle. The specimen is 6.5 cm. long by 4.5 cm. in diameter and grey in colour.

Pipe stems are predominantly like that on the first pipe to be described, i.e. plano-convex with the flat side uppermost, tapering to the lip and devoid of decoration.

Vegetable Remains

About 70 kernels of maize and one grape seed were found in the general refuse of the pits, and in a few cases, in small groups, at depths varying from one to nearly three feet. Dr. Volney H. Jones, Museum of Anthropology, University of Michigan, who kindly examined these, pronounced the corn ". . . to fit with out question into the 'Eastern Complex.' . . . type". (Letter of May 1, 1950.)

BURIALS

Human burial had occurred in two places; first, a multiple interment at the southern limit of the pit area and second, three or possibly four skeletons placed haphazardly in a refuse pit at the northern extremity of the site. In addition to these, there were 33 pieces of human bone found singly or in association with other material, but evidently these were not intentional burials. The only ones deserving of notice were two rugged tibiae belonging to a male approximately 5′6″ tall, which had been placed in a Maltese cross formation in the refuse pit. They were of a glossy brown colour when found. Since none of the other stray

FIG. 15. View of the group burial before the removal of any material.

specimens is deserving of special mention, it remains only to describe briefly the intentional burials, leaving detailed analysis for inclusion in another paper.

The multiple burial was an oval affair, containing the incomplete remains of eight individuals, ranging in age from infancy to adulthood (Fig. 15). It was situated at the extreme southern limit of the area containing pits, 20 feet east of the drop to the flood plain (see Fig. 3, shaded area). The burial was covered with a maximum of ten inches of soil, the rest having presumably washed away. A small pit, or rather the bottom of a pit, lying two feet south and west, may have had some ceremonial, but no functional, significance. In preparing the burial place, the soil had been removed down to clean sand and the surface levelled. Upon this, the remains were placed in such a manner that the skulls formed an oval 8¼ feet from east to west and 5¾ feet from north to south, containing, with two exceptions, all the other bones within it. The only artifact in the enire bundle was one sherd typical of the pottery of the site, and even its inclusion seems to have been accidental.

This extraordinary arrangement had been achieved only through doing violence to the remains. Whether this had been accomplished while they were in the flesh or subsequently is a moot point; the writer is inclined to the opinion that it had been done before disintegration occurred, or at least before it was complete. The possibility that they were kept in a charnel house previous to burial is also worthy of consideration. The usual condition was for the spinal column to be intact, with a severance occurring in the region of the pelvis. The lower extremities were frequently further disarticulated. All the skeletons were incomplete, several of them markedly so. Furthermore, most of the skeletons were scattered, for the femora and other bones of one skeleton were frequently found associated with another. Due to their nearness to the surface the crania were crushed to a greater or lesser degree, although usually not so seriously as to obviate all measurements. Most of the long bones showed recent breaks evidently due to the same cause. Aside from these factors, the bones gave no other indication of alteration in any way. Dissection must have been performed by an agent possessed of a good working knowledge of anatomy.

While detailed analysis of the osteological material may more properly be presented elsewhere, a few facts may be interesting in the present context. There were, for instance, at least three females, and two males in the group; the sex of the infants and the one child remaining indeterminate. The females were all placed on the south side of the oval, the males to the east and north. The females were all under twenty years of age, and the males from twenty to about forty-five. The child was about seven years old.

Pit Burials

Parts of three and possibly four skeletons were found in the refuse of one pit at the northern extremity of the site. Since the soil here had been greatly disturbed, the fragmentary nature of the remains may be due in part to that factor. Certainly none of the skeletons was complete, and one was represented only by a very small number of bones. These burials were entirely different from those

in the group interment, for they had evidently been deposited without regard to order, possibly even at different times, and not all at the same level. They seem to have been dismembered extensively, although not completely. That they were still in the flesh when interred is possible, but not proven. No marks of cutting or other deliberate alterations were found (except in the case of one femur, where a small round perforation occurred near the distal end, but since this was rough it may have been gnawed by a rodent).

The most complete skeleton comprised only the cranium and mandible; 16 vertebrae, 2 pelvic fragments, the right humerus, both radii and ulni, the right clavicle, both scapulae, the sternum, both hands, both femora and eight other fragments. The spine was oriented in a southwest-northeast direction with the proximal end to the north and was bent back sharply upon itself so that the face of the skull rested upon the lumbar vertebrae and almost in contact with the pelvis. The skull appeared to have been disarticulated. The scapulae were in approximately correct position. The humerus lay with the head resting upon the upper side of the skull and the distal end in articulation with its radius and ulna. The left humerus, as indicated above, was missing but the lower arm bones lay alongside the vertebral column. In both cases the hand bones were articulated and intact. The pelvis was fairly well preserved, and the left femur in articulation with it. The legs were flexed in an unusual fashion, doubtless just as they fell when thrown into the pit. The right femur was not in articulation, but lay slightly below the end of the spine and at almost a right angle to it. No ribs were present. The foot bones had probably been sheared off by the plough. The absence of one clavicle, the left humerus, fibula and tibia is difficult to explain unless the hypothesis is adopted that the skeleton was extensively but not completely disarticulated previous to burial. This would account also for the unusual position of the right femur and humerus.

The other skeletons were too fragmentary to justify any additional description here. Suffice it to say that no ribs were found with any of them, a condition noted also in the previous case. In summary, the burials in this pit were seemingly haphazard affairs, of no ceremonial import, and not in bundles. No grave goods of any kind accompanied them, and no special order was observed in the interments. The skeletons were partially dismembered but there is no proof that the cadavers had been utilised as food.

The people of this site, if we may rely on their rather scanty and imperfect remains, were dolicochranic and of medium stature. The two measurable females had estimated heights of 4′10″ and 5′ respectively; the males ranged from 4′9″ to 5′8″.

CULTURAL POSITION OF THE KRIEGER SITE

Enough has been said to show that the occupants of the Krieger site were a dolicochranic people participating in the Late Woodlands culture. They chose a position on the bank of a flood plain of the largest river in the area as the site of their village where the soil was fertile, free of stone and underlaid with hard

sand. The village was probably extensive, although only refuse deposits have been found. No fortifications of any sort were in evidence, in spite of the fact that the place was markedly vulnerable. No house sites, and no hearths were seen. Subsistence was obtained through hunting and fishing, with some slight dependence upon horticulture. Tobacco was raised, as is evidenced by the presence of smoking pipes. The site was intensively occupied, to judge by the concentration of refuse pits; these are of two principal types,—"bowl-shaped" and "beaker-shaped".

Stone, bone and clay were the principal materials used in the culture. Very little shell, if any, entered into the economy. Stone was used sparingly and with moderate skill. Projectile points were of four principal types, the predominant one being isosceles triangular with either straight or convex bases, but some had concave or straight bases as well. Corner-notched points were not uncommon, varied in size and shape, and usually were asymmetrical. Side-notched points were leaf-shaped, as were tanged points, the latter often asymmetrical also. Drills were used sparingly and were of two forms; expanded and those made from a spall. Scrapers were not common, and not consistent in form. Bone artifacts were rather rare, considering the quantities of material available. Catfish spines, deer ulnae and bird bones were all utilised in the making of awls. Bone tools were frequently highly polished.

The most abundant class of artifacts was the ceramic, vessels and pipes being freely made. Firing was rather poorly done, resulting in a soft, friable ware, usually of a reddish or reddish-yellow hue. It was made of clay mixed with crushed quartz for tempering, often in high proportions. Coiling was the method evidently employed. Vessels were predominantly of one shape, i.e., semi-globular with slightly everted rims, long necks and rounded bottoms. Maximum capacity was about five gallons, but most of them were smaller than this. The bodies of vessels were usually roughened with fabric or coarse textile; while about one-third of the total was left plain. The inside was likewise plain except for the rim which was sometimes embossed with anything from a few to an entire row of deep punctations; and/or with a band consisting of a design element present also on the exterior rim, neck or shoulder. The latter were almost always decorated with incising, designs made with cord-wrapped sticks, or by stamping or by a combination of these. Whereas the cord-wrapped stick technique was handled skilfully, the incising was rough and coarse. Stamping was carried to rather extreme limits, at least insofar as complicated designs were concerned. Dentate stamping was fairly common, but the extraordinary complicated designs resembling basketry were the most spectacular. Dentate stamp designs were frequently arranged into bold rectilinear patterns, such as diamonds. Incising was likewise rectilinear, and included chevrons, hatched triangles, and complicated patterns. Punctation was often used as an accessory technique. Adventitious decoration was lacking, but castellations and pie-crust lips were the rule. Briefly, it may be said that the Krieger pottery was abundant compared with other artifact types, and that it was lavishly decorated in the incising, stamping and

cord-wrapped stick impressing techniques; its chief distinction lay in the use of rhomboids, outlined and filled triangles and rectangles, and zoned effects as design elements. Incising appears not altogether as an innovation, but as something not yet mastered.

In the absence of reports on other sites of this culture, it is not easy to assess its full significance or its relations in time and space. It is, however, manifestly a Late Woodlands culture of the prehistoric period, and similarities both near and far serve to give some inkling as to its connections. More excavation in the lower Ontario peninsula and the adjacent states will be necessary before its precise position becomes clear; meantime suggestions as to the direction in which we may look for clues are all that can be given.

The nearest cultural relatives to come to light thus far are those reported in southwestern Ontario, by Lee, who has evidence of 19 sites. The number probably includes two or three known to Messers Coppieters and Wortner, and the site which Mr. Jury found in Camden township.

Possibly the burial is culturally connected which Wintemberg excavated in 1935 in the township of Sandwich West, Essex county (Wintemberg, 1936). Photographs of this were shown the writer by Mr. George MacDonald of Windsor, who assisted Wintemberg on the site and to whom thanks are due. Judging from the photographs and from Wintemberg's description, the skulls in this burial surrounded the other bones, just as in the burial at the Krieger site. The only other relationship within Ontario of which the writer is aware lies with the Uren site in Oxford county, and which shares pottery decorated with cord-wrapped stick, crude forms of incised decoration, rather coarse paste, and possibly similar tobacco pipe forms, scrapers, bone awls and anvil-stones. Lee, as a result of his survey in Southwestern Ontario, asserts that "From Krieger to historic Neutral the sequence is virtually complete", with "The numerous large sites of the Glen Meyer Focus, grouped in a broad oval, the long axis of which rests on Long Point and Ipperwash, form the connection between Krieger and Uren . . ." (Lee, 1952, p. 71).

More distant congeners are the Younge and Wolfe sites in Michigan and the Montague, Hannah and Clouse sites in western Pennsylvania. Similarities to the Owasco of New York are generic rather than specific; Ritchie and MacNeish identify only one ceramic type as common to both, i.e., *Owasco Herringbone* (Ritchie and MacNeish, 1949, pp. 110–11, Fig. 39, h, i, k). However, the combination of a rather tentative form of incising and a masterly impression technique occurs both at Krieger and at Castle Creek (Ritchie, 1934, p. 50), and is also present at the Snell and Willow Tree sites in the Mohawk Valley (Ritchie, Lenig and Miller, 1953, pp. 18, 20, Pls. 9–11).

Comparison of the Krieger and Younge sites brings out both similarities and divergencies. The Younge site differed from the Krieger in having several types of pit rather than the refuse pit only, in possessing stockades, and in different burial practices, chief of which was the presence of a few mortuary offerings, single and sometimes multiple burials, but no elaborate ceremonial formations such as was evident at Krieger. Furthermore, cranial perforation had been

practised at Younge, whereas its presence at Krieger is still unproven. As for the ceramics at the two locations, there exists undoubtedly a close relationship but not a total identity. Both show coarse grit tempering, medium to coarse texture, a predominantly brownish grey to buff coloration; bodies roughened to the shoulders done by fabric impressing or a cord-wrapped stick, wide mouths and rounded to conoidal bodies, slightly overhanging rim, nodes, or bosses, and decoration with dentate stamps, cord-wrapped sticks, cord-marking, punctation and incising, confined to the shoulders and rim and the inside of rims. The dissimilarities are most marked in the sub-conoidal base shape of Krieger vessels, the heavy fabric-roughening of their bodies, the much more frequent occurrence of castellations, the more lavish decoration, particularly in the technique of incising, the bolder designs, the absence of zoning and the greater miscegenation of techniques of decoration in the Krieger ware. It is in the clay tobacco pipes that the resemblances seem strongest; in our Fig. 14, these are stylistically extremely close to Greenman's Plate XXI, figs. A-C. And while the shape of the Krieger pipes seems to be nearly constant there is a significant variation between it and the shape shown at D in the same plate in the Younge report, the latter being almost a straight right-angled specimen. The Krieger variants (Fig. 14:3) are lacking at Younge and conversely the Younge variant appears to be lacking at Krieger.

The stone inventory was larger at the Younge site than at Krieger, and more diversified; and the general impression, in comparing the two, is that the material at the former is less carefully made, cruder and rougher. Certain forms are similar, especially the triangular points and the drills.

Physically the inhabitants of both sites were short in stature, predominantly mesene and orthognathous. All Krieger skeletons which gave useful measurements were dolicochranic and differed in some other respects from those at the Younge site, though generally speaking they seem to have been physically very similar.

Thus, while there are striking similarities between the cultures of the two sites, they are by no means identical, the chief differences being in the more elaborate decoration of the pottery and particularly the exuberant use of incising, the more conoidal shape of the vessels and the greater abundance of castellations at Krieger as compared with Younge. Important differences in mortuary pattern are also apparent.

Correspondences likewise exist between the Krieger and Wolfe sites, also excavated by Greenman in Michigan. The location near water was similar, pits were found at both, and side-notched and corner-notched points were found at Wolfe. The Wolfe site burial was flexed and had grave goods, however, and while there is a general similarity in pottery in that both Krieger and Wolfe wares are castellated, with plain or surface textured bodies and decoration confined to the upper parts, and this decoration was often arranged in somewhat similar pattern, the resemblances do not carry much further. Cord-marking, impressing with cord-wrapped stick and incising were utilized at both sites, but the individual results were not greatly similar. It is rather in the presence of

these, and in the free way in which they were experimented with at both places that the true correspondence exists. At the Wolfe sites linear stamping was used in a novel way (Greenman 1939, Pls. V and VI, Fig. 1) while at Krieger it was used in a different but equally novel pattern, indicating a common base for the two products, a freedom in experimentation and hence a possible contemporaneity.

The Montague site, in western Pennsylvania, excavated by Miss Butler in 1936, exhibits certain correspondences with the subject of this report, especially in its ceramics. At both sites, pottery seemed to be more abundant than any other type of artifact, and pipes were present at both. The pottery of the Montague site, like that at Krieger, was predominantly grit-tempered (Butler, 1939, 20) with a sprinkling of shell-tempered sherds at the former (*ibid.*, 21); and much of it bore a wide-line incised decoration, which Miss Butler considered unique to the area, but which is evidently similar to types from Krieger (*ibid.*, 30, Pl. 9 a–b); the incised and punctate sherds illustrated in the same report, Pl. 10, a, d, are likewise comparable. The most striking similarity, however, is exhibited in the clay pipes; although these are obtuse-angled, and elbow-form, whereas the Krieger specimens are right-angled, both bear almost identical rouletting. Moreover, the use of this technique seems to be the dominant one for pipes at both sites, although others do occur. Apart from the slight difference in shape, pipes at the two sites are almost identical. Correspondences between other traits are not strong; burials at the Montague site were mostly single, flexed inhumations, with some grave goods; polished stone tools evidently were more frequently used; the bone industry was represented by a larger range of artifacts, and there were some specimens made of shell. The Hanna and Clouse sites, which Miss Butler includes with the Montague site to form the Monongahela Aspect, have of course similar material, but the specific correspondences to the Krieger culture are fewer.

SUMMARY

The Late Woodland culture represented at the Krieger site appears to have its centre in southwestern Ontario, but the barrier of the Great Lakes has not been effective in isolating it entirely to this area. Probably by means of the chain of islands across the western end of Lake Erie, it maintained some sort of contact with cultures on the eastern shore, most notably with that of the Monongahela Aspect, which are thought to be proto-historic, and to have influences from Fort Ancient. No evidence of the latter is apparent at Krieger, which seems to represent a single population unit and a restricted time span, i.e., a homogeneous culture. Moreover, there is no question of its being prehistoric. It would appear that with the Montague site, particularly, certain traits were held in common, e.g., the shape of vessels, and the roulette decoration and shape of pipes have been retained. In the Michigan direction, there is a close affinity with the Younge and Wolfe sites, although here there are significant differences in burial customs, pottery decoration and certain features in the lithic industry.

ACKNOWLEDGEMENTS

The author wishes to acknowledge with gratitude the assistance of the Canadian Social Science Research Council in making possible the publication of this report. He also wishes to express his thanks to Dr. William A. Ritchie, State Archaeologist for New York, for his kindness in reading the manuscript and for his helpful suggestions.

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TRANSACTIONS

of the

Royal Canadian Institute

VOLUME XXX

1953 — 1954

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